INDIAN RAILWAY ECONOMICS

PART II

LECTURES

ON

INDIAN RAILWAY ECONOMICS

(TRANSPORT SERIES)

PART II

BY

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[FORMERLY OF THE G. I. P. RY. AND THE E. I. RY.;

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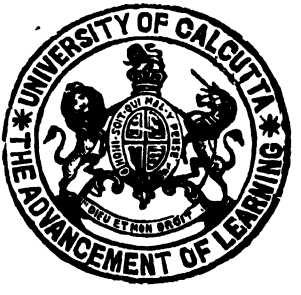

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PREFACE

In publishing these lectures on Railway Economics I neither claim perfection, nor do I pose myself as an authority in the subjects I have dealt with. I have gained some knowledge and experience, which I place at the disposal of the students of the Calcutta University. I had opportunities, which many others amongst my countrymen had not had, and if the young gentlemen, who want to make railroad working their future profession, profit in any way by these publications I shall feel very glad.

I am conscious of the deficiency of my knowledge and education, but all I can say is that I have done my best. It is this deficiency which makes me feel all the more grateful to the Hon'ble Sir Asutosh Mookerjee, Kt., M.A., D.L., Ph.D., etc., for appointing me Honorary Lecturer on Railway Transport of this University. His anxiety to do the utmost for the advancement of learning is well known, and India owes him a very great deal in this respect. And I only wish I have been able to do something in a small way in the direction he wanted me to work.

I am, however, glad that Railway men of India like Sir Robert Highet, Kt., C.B.E., Deputy Chairman of the E. I. Railway Board of Directors, and Col. G. Huddleston, C.I.E., Chairman, Nizam's Railway and Managing Director, Assam Bengal Railway, and for many years General Traffic Manager, E. I. Railway and sometime Acting Agent of the E. I. Railway, under whom I had the honour to serve, have considered the first part interesting and useful, I do not, however, deserve the compliment these two gentlemen have paid me for the work.

My grateful and sincere thanks are also due to Mr. C. D. M. Hindley, M.A., M.I.C.E., Chief Commissioner of Indian Railways, for the encouragement I have received from him in this connection. He was so kind as to say that had it not been for his present position he would have been glad to write a Foreword for Part I.

53, Lansdowne Road,
Calcutta:
January, 1923.

S. C. GHOSE.

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INDIAN RAILWAY TRANSPORT SERIES

No. 1

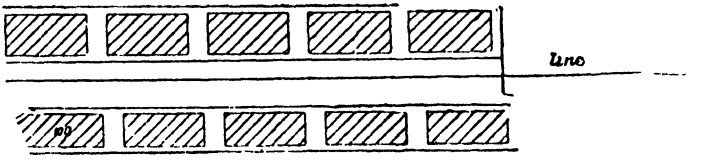
PERMANENT WAY

The railways in India are distributed between four gauges, *viz.*, (*a*) 2′ 0″, (*b*) 2′ 6″, (*c*) 3′ 3⅜″, (*d*) 5′ 6″. The gauge is the distance between inside edges of two rails which form the track; this will be explained and illustrated a little while hence.

The railways on the first two gauges come under the head of light railways and are sometimes built on made-up roads that is on one side of a public roadway such as the Howrah-Amta, the Howrah-Sheakhala railways in Howrah District in Bengal.

In the case of the 3′ 3⅜″ and 5′ 6″ gauge railways and also in the case of many other light railways, the road bed has got to be made up. For this purpose land is acquired and all obstacles such as houses, trees, etc., are removed and tanks and pits filled up. Then the earthwork is done by raising an embankment out of earth, dug out from the pits made on both sides of the proposed railway line, leaving room for a double line embankment in the case of 5′ 6″ gauge railways. Although in the first instance the embankment may be made for single line only, sufficient land is got for another line. A diagram showing the railway line with side-pits on both sides is given below. (See Figure I.)

Fig. I.



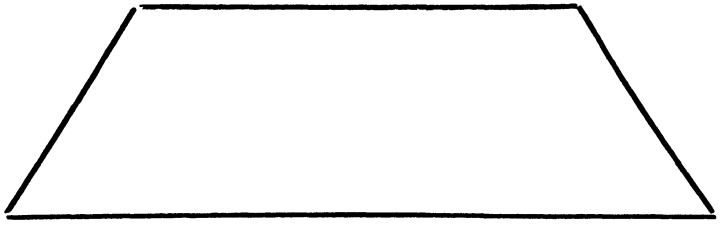
The width and depth of the side-pits depend on the amount of earth required at each place, but they are generally of

uniform length and are not connected with one another, the main reason being that if pits are so connected they may eventually form into a running channel specially during the rains and endanger the embankment. But these side-pits, it is argued, help, by reason of having stagnant water in them, to create unhealthy spots in the country.

An embankment is made by filling up and by raising as contrasted to a cutting which is made by cutting a raised ground.

The following is the diagram of a cross-section of an embankment. (See Figure II.)

Fig. II.

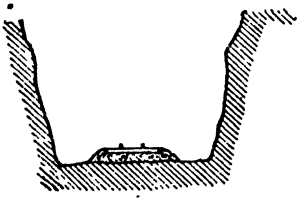


The slopes are generally 2 to 1.

As just remarked, the road-bed is made up *by raising the ground level* and sometimes *by reducing the ground level,* by cutting through raised ground and these are known as cuttings as distinct from an embankment.

The following diagram shows the cross-section of a railway line running through a cut made through a raised ground. (See Figure III.)

Fig. III.



There are side-drains on both sides of a railway line made inside a cutting in order to drain rain water out of the cutting.

After an embankment is raised it is allowed to settle down a bit, and after one rainy season has passed over it sand ballast is thrown to help consolidation. Then the stone or broken brick ballast is laid and the rails are laid on sleepers (wooden or iron). It may be mentioned that there is not much harm in laying the rails on an embankment partially settled, *i.e.*, before stone ballasting. The running of engine settles the bank and makes it even, the engine acts the same as steam rollers do on roads.

The stone ballast may be subsequently spread, when the bank is rather firm, and put under the sleepers by slightly raising the sleepers with rails on them.

The rails are either flat-bottomed or are double-headed. The double-headed rails are laid inside a cast iron chair and the rails are wedged in with a piece of wood to make them tight, and the flat-bottomed rail is laid on sleepers and spiked on them. (See Figures IV and V.)

Fig. IV.

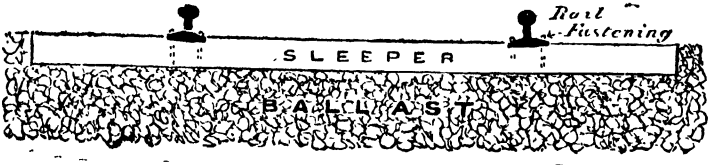
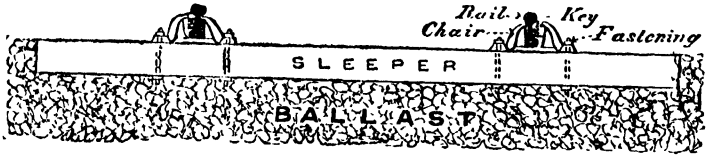
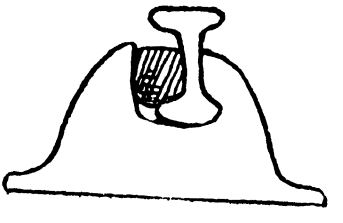


Fig. V.



The following is a more clear diagram of a double-headed rail inside a chair with a wooden wedge holding it tight. (See Figure VI.)

Fig. VI.

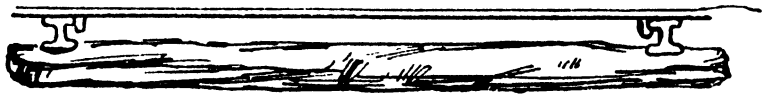


A line of railway is the name of a pair of rails on which railway trains run.

The gauge of a line is the inside space between these two rails, and there is left a space of $\frac{1}{4}$ to $\frac{3}{8}$ or $\frac{4}{6}$ of an inch between the wheel flange and inside of the rails.

The following is the diagram of a Permanent-way man's gauge-stick on rails used for testing the gauge between the inside of two rails, shewing exactly the gauge between the rails. (See Figure VII.)

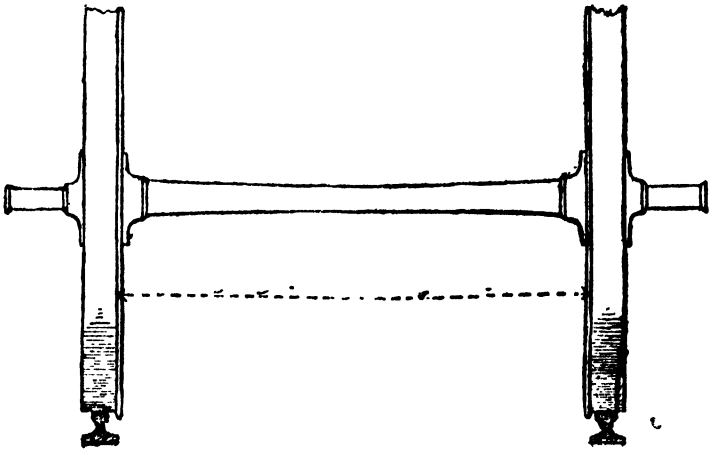
Fig. VII.



The wheels of rolling stock are made with flanges to prevent the wheels from leaving the track and the following is a diagram of wheels on rails; the flanges of the former sink inside the inner sides of two rails. (See Figure VIII.)

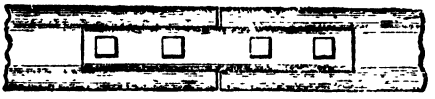
There is a space allowed between the wheel flanges and the rails as stated already.

Fig. VIII.



The rails are of certain lengths and have got to be joined to one another by means of fish plates which are bolted to the rails to hold them together as shewn below.

Fig. IX.



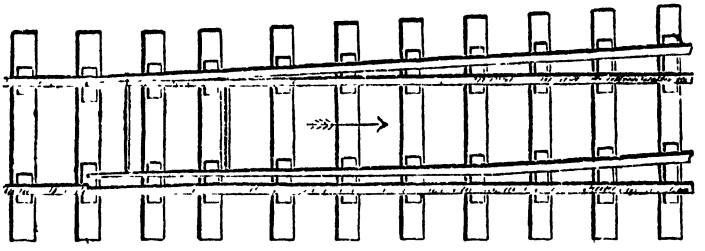
In order to enable movement of wheels from one pair of rails to another there are the transfer points and crossings.

Points are practically moving rails, by moving which the direction in which a train or a vehicle is moving is changed. The change of direction commences from the point where the tongue of the moving or the point rails touches the stock rails and the transfer is completed when the vehicle or train has passed over the crossings at the other end of the point rail.

These point rails are manipulated by levers and rods. the rods being connected with the rail and the levers with the rod.

The following diagram shows the stock rails, the point rails with tongues and the rod that manipulates the points. (See Figure X.)

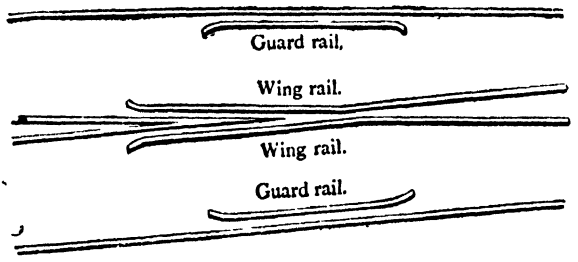
Fig. X.



In this case the rod has been pulled and the points are set for the divergent line, but if the lever that pulls the rod is thrown back the points will be reset for the through lines.

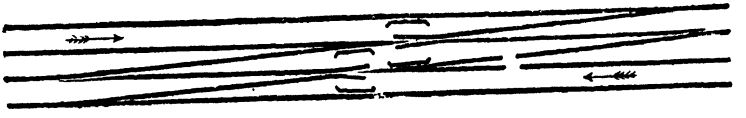
The following is a plan of a crossing. (See Figures XI and XII below.)

Figs. XI & XII.



Below is a sketch plan of points and crossings and of the positions of these in both directions and of the connections :— (See Figure XIII below).

Fig. XIII.



INDIAN RAILWAY TRANSPORT SERIES

No. 2

TRAIN SIGNALLING AND TIME TABLE

Mr. Byles, one of the Special Lecturers on Railway Economics at the University of Manchester, writes as follows in his able work on "Railway Signalling."

"Transportation on railways is afforded by the movement of trains, and greater the amount of traffic which can be handled on any given section of a railway the greater its earning capacity. As a corollary to this axiom it follows that less the risk of accident to the traffic the smaller will be loss due to damage and delay. It is merely stating a truism to say that the operation of a railway as a commercial undertaking under the conditions existing to-day would be absolutely impossible without a signalling system. And in the expression Signalling System is included the whole of the means and methods whereby movements of trains are conducted."

Before passenger trains can be run, the Government rules require that certain precautionary measures should be taken for the safety of passengers and the general rules laid down by the Government of India provide that the safety of passengers must be the first duty of railway servants.

On some railways, there is a separate pair of rails for trains in one direction and another pair for trains in another direction and such lines are called double lines, but on a great majority of Indian railways the line is single and not double, *i.e.*, both up and down trains run on the same pair of rails.

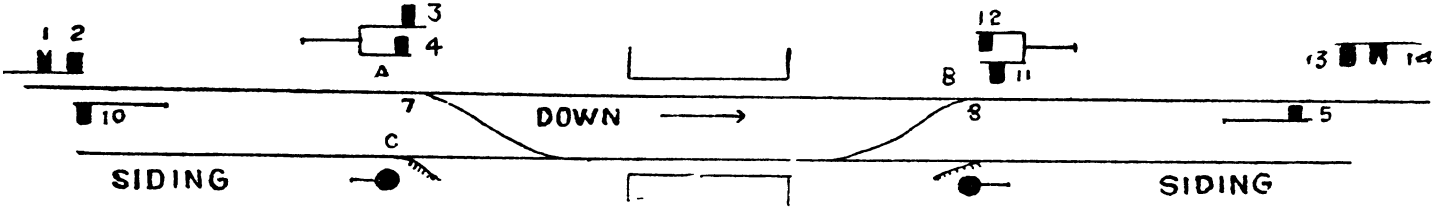
On double lines, the trains only follow or overtake one another on the same track, whereas on single lines the trains follow, overtake and cross one another from the opposite directions. But in all cases none of these operations can take place

except within the limits of a station except that on double line trains from opposite direction cross one another on road, *i.e.*, outside station limits, but on separate tracks.

The station limits are between two distant fixed signals, which are each at the opposite extremities of a station. These extremity signals are known as outer signals.

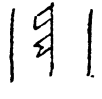
The following is a diagram showing the signals at a station on a single line, where there is a main line, a loop and sidings connected by points from both sides. (See Figure XIV.)

Fig. XIV.



Let us be a bit more explicit. Taking a train proceeding towards the down direction, there is first the outer signal, which has two arms (Nos. 1 and 2) which are ordinarily up, *i.e.*, raised at right angles to the signal post. If they are lowered, it means permission is given for the train coming going in the down direction to enter the station. When the arms are lowered, the position is thus (see Figure XV).

Fig. XV.



To revert to Figure XIV; there are two arms to the outer signal (1 and 2) the upper arm No. 2 is the signal for a down train to enter the station, and the lower arm (the fish-tailed one) No. 1 if lowered along with the upper (it cannot be lowered singly) indicates that the train is not intended to stop at the station, but is intended to run through the station.

Then the arms 3 and 4 of the Home signal are indicators and permitters for the down train to come on either to the main line or to the loop. If 3 is lowered, it is a signal for the train to come to the main line. And if 4 is lowered it is for the loop line.

No. 5 is the starting signal and when lowered, it means that the train can start for the next station.

But this signal cannot be lowered until permission to start the train has come from the station ahead. The names of the various signals are given below :—

No.	1	is the	Up	Warner
,,	2	,,	,,	Outer.
,,	3	,,	,,	Home for Main line.
,,	4	,,	,,	Home for Loop line.
,,	5	,,	,,	Starter.
,,	10	,,	Down	Starter.
,,	11	,,	,,	Home for Loop line.
,,	12	,,	,,	Home for Main line.
,,	13	,,	,,	Outer.
,,	14	,,	,,	Warner.

8, and 7 are points for movement of trains from one line to another.

On a single line station the signals for one direction only can be lowered at the same time, that is, say, if a Down train is permitted to enter the station limits an Up train cannot be, at the same time, so permitted as well. If two trains (*i.e.*, one train from each direction) are due at the same time, then, in the first instance, the outer signals in both direction must be at danger, so that both the trains must come to a stand outside

the outer signals. The station master will, at his discretion, give signals for one of the trains to enter. He will do so by first lowering one of the Home signal arms and then by lowering outer signal. Suppose a down train is first permitted to enter the station say on the Main Line this will be done by first lowering Arm 3 of the Home signal and then by lowering outer signal arm 2 (the normal position of point 7 being for the Main Line).

When the down train has entered the station and come to a stand and stood clear of and at an adequate distance from point 8, and also clear of and at an adequate distance from point 7 then permission will be given for the up train to enter the station, which will be done by first lowering arm 11, which again cannot be done until point No. 8 has been set for the loop line, and when all this has been done arm 13 will be lowered, when the up train will enter the station.

After the up train has come to a stand on the loop line, the Down train can proceed, but before it can do so point No. 8 must be reset for the main line and then the starter signal (arm 5) will be lowered. Similarly, the up train can leave the station when point No. 7 has been set for the loop line and after starter signal (arm 10) has been lowered.

Trains generally start from what are called terminals, which are generally either at big port towns or are Junctions of railways.

Passenger trains start from the terminals and a number of them run from one end of a railway to the other, at any rate some at least are such through trains. These trains consist of passenger vehicles, First, Second, Inter and Third classes, luggage vans and brake vans. They are generally run intact, *i.e.*, they are not disturbed from the train on the road. Some passenger trains run over more than one railway such as mail trains from Calcutta to Bombay and *vice versâ*.

Seeing that the trunk railways of India are the property of one proprietor, namely, the Government, the running of through

passenger trains over more than one railway might to be more general. This will not only save passengers from the trouble of changing at the Junction Stations but will effect a saving in the amount of passenger rolling stock required for railways, provided that such through trains are fast trains ; slow trains for long distances mean more carriages as it takes longer to turn round the carriages. At present, whereas the interchange of goods vehicles between railways is unrestricted the interchange of passenger carriages is restricted.

A large number of coaching vehicles of several railways are kept waiting from 12 to 24 hours or so at the junctions; they could be run for a couple of hundred miles or more over another railway and thus render more service ; *i.e.*, the time they would be moving on wheels would then be greater than at present. Passenger trains require more care and attention specially from the point of view of safety and convenience of passengers, yet the passenger train service is comparatively easier to manipulate than goods train service and similarly, the passenger traffic working is easier than goods traffic working, at least less complicated.

Goods trains also start from terminals and Junctions. There also are fresh trains formed at intervals of seventy to hundred and fifty miles in many cases, although such trains carry wagons, some of which are from or for the terminal station. On coal booking lines a very large number of wagons are from the coal-field districts and trains start from there.

There are "Changing stations" say from 70 to 150 miles apart from one another and at such stations fresh trains (specially sectional trains) are formed. These were called changing stations for the chief reason that they were stations where engines of trains were changed and so also the engine crew ; and sometimes the guards as well. These changing stations are called terminal stations also now-a-days. They play a very important part in the matter of working of trains on Railways, because most goods trains run between two changing stations and are broken and formed again at these changing stations.

The distance between two changing stations is called a section and this section is again subdivided into "block sections." The length between two line-clear stations is called a "block section." Each line-clear signalling station is fitted with electric or electric telegraph appliance, by means of which it can communicate with stations on each side. The distance between block-sections varies from ¾ of a mile to even 12 miles or more, but the shorter the length of a block-section the easier it is to get the trains through quicker provided that in such cases the stations are provided with interlocking arrangements between signals and points.

If human agency alone is employed on busy sections and each point and signal is worked solely by pointsman and signalman, it may happen that while the signal may be given for one line the point may set for another, and besides the facility for quick running of trains would be very much reduced and thus the capacity of the railway for train movements will also be reduced. Therefore, a system has been devised under which a number of signals and points are manipulated from one signal cabin under control of one man and also the points and the signals are so inter-locked with one another, by mechanism that it is mechanically impossible that the position of the points should be different from the signals for it. Further the combination of points and signals can be increased and all connecting points and signals can be so interlocked that no conflicting signals can be given or wrong points set; and the consecutive points and the signals for them can be so inter-locked that they would all work in harmony with one another in order of succession as arranged according to requirements. Taking Figure XIV if a down train is to be received on the main line then first, point No. 7 must be set for the main line, and then only arm 3 of the Home signal can be lowered and then the outer signal arm 2. The levers in the frame are inter-locked in such a manner that it is impossible for unsafe combination of lever movements for points and signals to be made.

Next, to deal with signalling of trains from one station to another. Suppose there was a section of a railway which was forty miles in length and the stations on this section were uniformly five miles apart from one another and the section was thus divided into 8 block-sections as follows:—

A——B——C——D——E——F——G——H——I

(A, B, C, D and so on may be taken as the names of the stations of a single line.)

Then suppose a train is ready to start from A, the man in the signal cabin at A will give warning on the electric instrument to B, who will acknowledge the warning and give permission to A to start the train unless B has got another more important train in the opposite direction, *i.e.*, from B to A. In the latter case B will ask for counter-permission to start his train in preference to the train from A. Let us however, assume that B has not got such a train and permits A to start his train. A will do so by handing a token or a written line-clear message to the driver of the train ready to start, giving the necessary permission but even then the train cannot move until the signal (*i.e.*, the starter signal) for it is lowered. The moment the train leaves A, A will notify to B the departure time and the moment the train has arrived and stopped at B, B will notify this on the electric instrument to A, and the block will be removed from the line between A and B and this section of the line will then be in a position to receive another train. Further, B on receipt of the warning from A would in its turn ask C for permission to send on the train further after its arrival at B, and all this procedure observed in connection with the despatch and receipt of trains from A to B will be repeated at B, C, D, E and so on.

Time-Table.

For purposes of safe and proper running of trains a time-table is essential. Thus a time-table is to be very carefully manipulated so as to avoid collision, detention and unnecessary loss in steam, coal, oil, allowances to the train crew, and capacity,

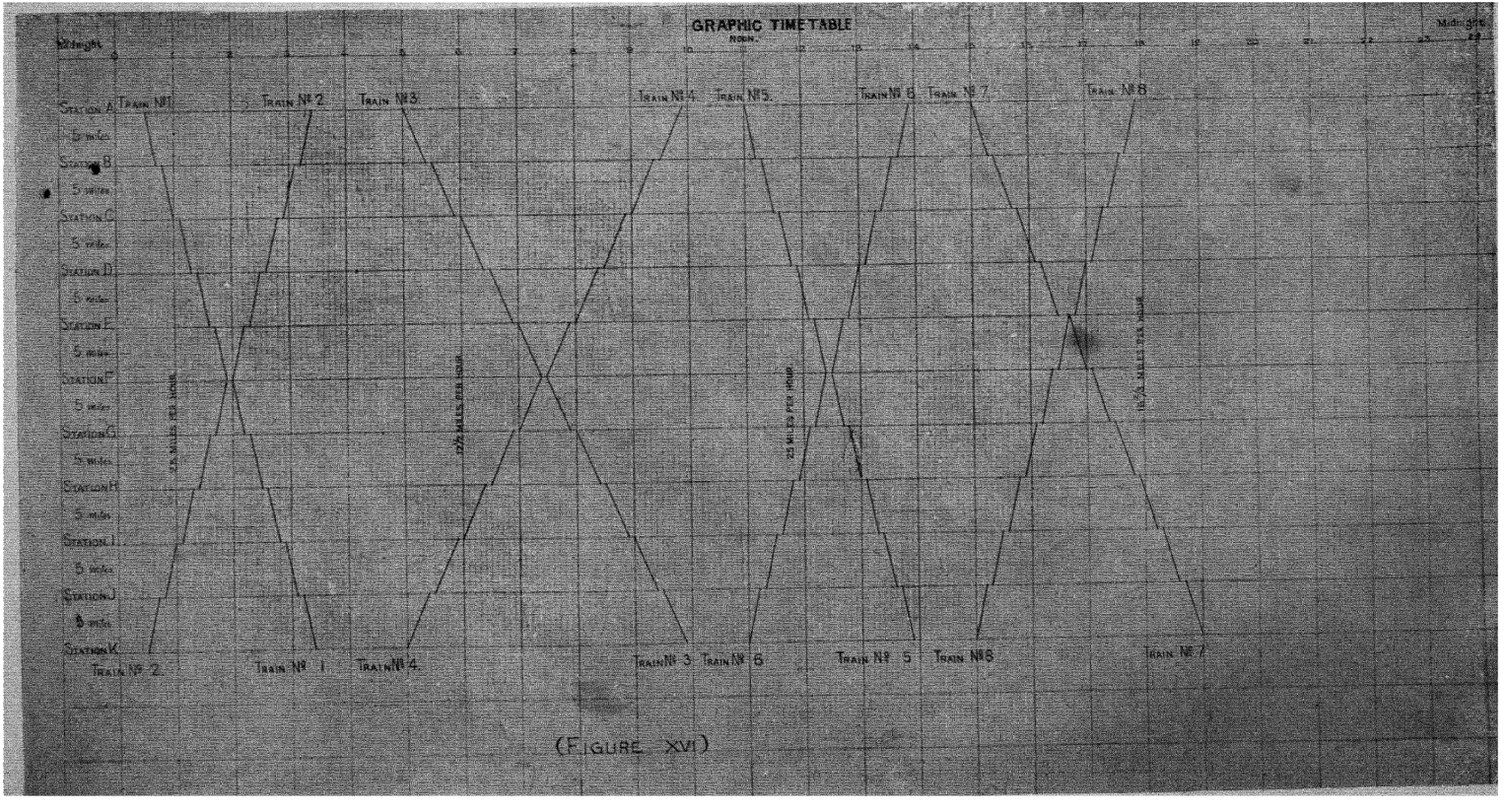
also to ensure safety and to give preference to important trains and to arrange crossings of trains at convenient points.

Passenger trains take precedence over goods trains except that fast through-goods trains, that do not stop at intermediate stations, are given precedence over slow passenger trains. And mail trains take precedence over all trains.

Therefore, the time-table of fast trains (mail and fast passengers) is taken in hand first and then the less important trains and so on ; and in the case of single line one up and one down train (corresponding) (*e.g.*, one fast up train and one fast down train) are worked out on the time-table graphic chart and so on. For this facilitates the working out of timetables or otherwise if all trains in one direction (fast and slow) are first worked out and then trains in another direction are taken in hand it would be impossible to arrange convenient, economic and suitable runnings and crossings, and heavy detentions to trains in one direction must occur.

It is convenient, easy and safe to work out train time-tables on a graphic chart. A diagram of such a chart is given in Figure XVI.

Fig. XVI.



(FIGURE XVI)

The vertical lines represent time. The day of 24 hours is divided into 24 sections, and each section into 10 or 12 small sections of 6 or 5 minutes each in the chart; in Figure XVI, however, the smaller sections are ten of six minutes each. But it is convenient to have these smaller sections of 5 minutes each.

The horizontal lines represent the distances, which for the sake of convenience, *i.e.*, in fitting in trains for purposes of the illustrations in the chart, have been taken at uniform lengths of 5 miles each.

The diagonal lines represent the trains. The fast trains have been worked out at a speed of 25 miles per hour (Nos. 1 and 2, and 5 and 6) and the next fast trains (Nos. 8 and 7) at $16\frac{2}{3}$ miles per hour and the slow trains (Nos. 3 and 4) at twelve and half miles per hour and the stoppages at each station have been taken at 6 minutes for all trains.

The fast trains at 25 miles an hour take 12 minutes between each pair of stations, the less fast trains, at $16\frac{2}{3}$ miles per hour, take 18 minutes and the slower trains, at $12\frac{1}{2}$ miles per hour, take 24 minutes.

So the diagonal lines for 25 miles per hour trains occupy between a pair of stations 2 of the 6 minute squares, the $16\frac{2}{3}$ mile per hour trains 3, and the $12\frac{1}{2}$ mile slow trains 4 of such 6 minute squares (representing 12, 18 and 24 minutes respectively).

The trains from A to K may be taken as Down trains and they are shown as moving downwards on the graphic chart, and the trains from K to A may be taken as Up trains and they are shown as moving upwards in the chart. With the help of a calculated speed table, a set square or a parallel ruler and pencils, the the timetable between stations can be drawn out on the chart.

The time occupied by trains between stations depend on—

(1) Grades.—Suppose the grade is steep in the up direction and sliding in the down direction, an Up train would take longer time to accomplish the journey than a down train.

(2) The speed of a train is dependent on the running power of various classes of engines. Some engines are designed for

fast running (*e.g.*, mail or fast passenger engines) with lighter loads while others are intended for trains at a less speed, *i.e.*, slower than the fast passenger or mail engines, but to pull and draw heavy loads.

The capacity of a section between two changing stations for moving a number of trains depends to no small extent on the accommodation at stations on that section for receiving and despatching trains, which is limited by the number of sidings and lines existing for receiving, holding and despatching trains; this will be discussed subsequently. Let us return to time-table for the present.

As already stated, the time-table of goods trains is taken in hand after the mail and passenger trains have been worked out and drawn on the graphic chart; fast through goods trains or perishable traffic trains generally take precedence over slow passenger trains, which stop at every station. Goods trains, except fast through goods trains, are not run to time always; they take in their chance as they proceed along. It is the practice with time-table clerks to chart out passenger trains over a section, lying between two changing stations, first and then to fit in the goods trains, regard being had to locomotive department requirements for coaling, watering, the accommodation at crossing stations for trains to cross, and to requirements for traffic purposes. The speed of a train also depends on the condition of the permanent way.

If there were uniformity of distances between all block sections or rather if the running time between all block sections had been the same on a section the run of trains of uniform speed would have been very regular, but this ideal condition is hard to obtain and besides trains vary in speed. During recent years, attempts have been made, by increasing the number of line clear stations, to reduce the lengths between block-sections, and consequently the runs between block sections, in order to get the trains through quick.

On busy sections of a double line, block-sections occur frequently, and are sometimes one mile (even ¾ or half mile) apart

on busiest sections, on others 1½ to 2½ but mostly 3 to 4½ or 5 miles, and in some cases 7 to 9 miles apart (sometimes 12 miles.) The occuring of one "block-section" of 7 to 9 miles or of a greater length on a section of say 100 miles (even with closer distances between the remaining block-sections) would limit the capacity of that section in the matter of movement of trains, because the number of trains that can be run through from one end of the section to the other would be the number that can get through in 24 hours between two "line clear stations" forming the longest block section. The speed of trains to no small extent depends on clear and short block-sections, but it may be mentioned that very frequent occuring of stations, unless they are "interlocked," impede the running of fast trains, which have to lower down speed when passing through stations where points and signals are not interlocked with one another. For purposes of quick passage of trains convenient station yards are essential.

In a fairly important station yard there should be one up and one down platform lines, and one up and one down loop lines, so that two up and two down trains can be conveniently dealt with at a station (*i.e.*, trains arriving within short intervals of one another).

But suppose if there were only one up and one down lines, and no loop lines, or sidings at a station, it would not be possible for say a goods train or a slow passenger to be held back and detained at such a station to make room for a following fast passenger, which requires to be given precedence and has already arrived at the last station. In such a case the goods train or slow train must go ahead till it reaches a station where there is accommodation to stable such a train and to let the fast passenger pass. Naturally therefore the slow train ahead will cause detention to a fast train, which is following closely behind.

At a station with goods traffic there are the sidings for the goods shed as shewn in the following diagram marked Z; generally all goods (up and down) are dealt with

in the same goods shed at road side stations. Therefore, there are siding lines for the goods shed connected with the main lines.

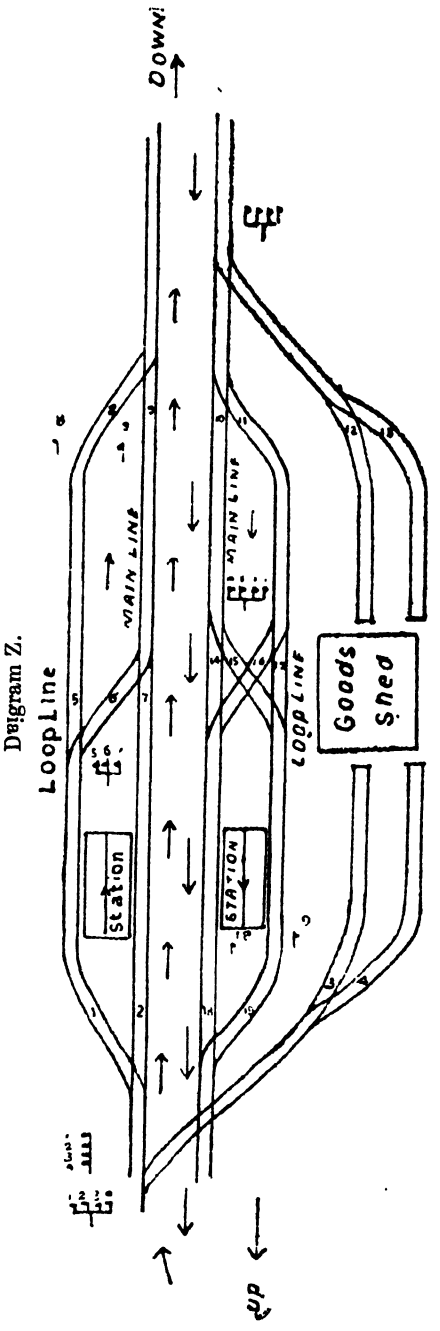


Diagram Z.

Further, too many curves and steep grades are factors that operate against economic working. Steep grades and sharp curves restrict speed, and high speed on sharp curves is often dangerous. Therefore the Railway Engineer has to bear in mind, in laying out a railway line, that the grades are not unduly steep and that the curvatures are not too sharp and more in number than are absolutely necessary. In hilly, undulating rugged countries the grades are in many cases unavoidable and also sometimes curves and grades are indispensable to save right of way or on bridge approaches or to avoid buildings, religious edifices, tanks, etc. It has, however, to be remembered that the object of a railway is to earn money and to make profits, and therefore, if the avoidance of grades means unduly heavy expenditure on construction the grades are in such cases indispensable, but a calculation is necessary to see whether heavy grades will cause permanent increases in operating expenses, in the way of additional and more powerful engines, limited loads and speeds and thus more than counter-balance the advantages of cheap construction. Similarly, in the case of curves, if it is found that a straight line would not serve a big town or commercial centre, which might in the long run require a short branch or retard the development of traffic, in that case it is better to have the line on a curvature, in such places, than on straight. Due judgment and caution are necessary and one ought to make as careful an estimate as possible "of the details of the problem and accept the final result in profit on the capital outlay as an absolute guide."

INDIAN RAILWAY TRANSPORT SERIES

No. 3

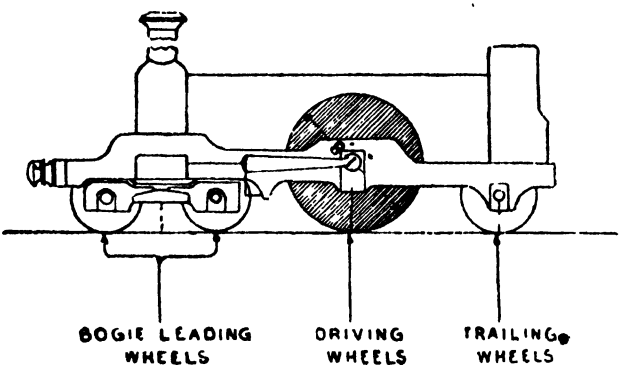
ROLLING STOCK WITH ITS RELATION TO RAILS USED AND CARRYING CAPACITY

It is required that the rails should bear all the weight that is required to be placed and hauled over it. Engineers have after experiments and calculations come to a basis in this respect. It is held for the weight of rails per each five lbs. to a yard they bear a weight of one ton.

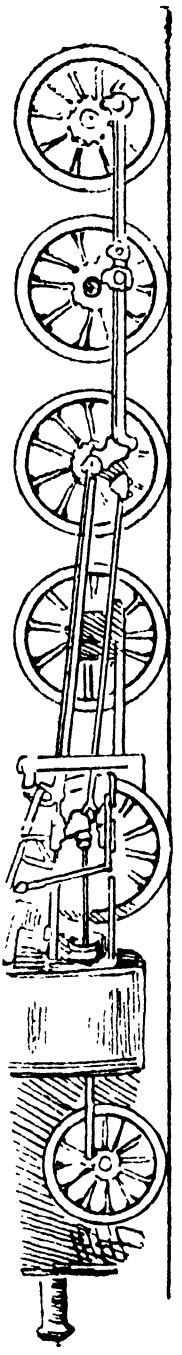
The heaviest load of all the vehicles on a train is that of the engine and the weight of a vehicle is distributed over its axles Each axle has two wheels ; so that half the axle load is the weight on each of the two wheels attached to the axle. On the basis of 5 lbs. per yard of a rail to a ton of axle load for 7 ton axle weight, the weight of rails should be 35 lbs. per yard, for 10 ton axle-load 50 lbs. per yard, for 15 ton axle-load 75 lbs. per yard and so on. And the rails are thus known as 35 lbs. 50 lbs., 75 lbs., 80 lbs., 90 lbs., and 100 lbs.

In the early days of railway, an engine was mounted on a pair of leading wheels, a pair of driving wheels and a pair of trailing wheels. (See Figure AA below).

FIGURE A.A.



The leading wheels may be the wheels of a bogie and the driving wheels may be coupled together. The coupling of



3B.

several pairs of wheels is done in order to distribute the weight of an engine, which weight if concentrated on any one pair of wheels may tell on the rails, and the use of a bogie truck for leading wheels facilitates the movement of engines on a curve as will be shown later on.

The figure BB shews the wheels of a modern engine in which the last 3 pairs of wheels are coupled together.

In designing locomotive engines particulars such as following have got to be taken into account :—

(1) Gauge. (2) The radius of the sharpest curves and lengths of the same. (3) The steepest gradients and the lengths of the same. (4) The average grades. (5) The distance between two watering stations. (6) The weight of rails per yard. (7) The number of sleepers per rail or the distance apart from one sleeper to the other. (8) The average load of the train and the maximum load the engine is to be required to haul. (9) The speed required. (10) Quality and analysis of coal and water. (11) The buffer and draw gear requirements.

The fast train engines are so designed as to be capable of running fast, whereas with goods train engines the power of hauling big loads is a more important factor. With the various designs of engines the speed and the loads differ.

Locomotives are not yet made in India ; so far only their erecting has been done in India. Then whereas the big repairs and thorough over-hauling are made in the Central Locomotive shops of a railway there are at engine changing stations small workshops, attached to Engine sheds, where small repairs and cleaning out, etc. are done.

Although carriages for passengers and goods wagons are made in India the wheel tyres, axles, springs, couplings, buffers are yet imported to a large extent. The underframes of wagons have been made in India out of iron manufactured by Tatas and the wheel centres are also made in this country out of steel castings and so also the axle-boxes and buffer casings. The carriage bodies are made in India and are generally of wood work but in respect of wagon bodies the iron and steel for the

sides and the roofings have also yet to be imported. Endeavours should be made to manufacture rolling stock in India, and it is believed that before very long engineering works to build engines, carriages and wagons may be started in this country.

It is true that in the case of Indian Railways the labour and the cost of brick work in the buildings, earth work in the embankments, ballast, &c., are cheap, but it is to be borne in mind that the cost of iron and steel goods, including bridge girders, rolling stock, machinery, tools and plant, is higher than in Europe because we do not manufacture them in India. So far we have only manufactured rails in this country but until we manufacture most of our railway materials in India and also cheaply and efficiently we cannot say that we are self contained in the matter of our railways. It is true that there are several engineering and railway workshops in this country, but these so far mostly do assembling, erecting and repairing work. As to rails so far Tatas' shops are the only ones where rails are rolled. The Indian Railway workshops should be gradually turned into manufacturing and building works rather than allowed to remain as repairing, assembling and erecting shops.

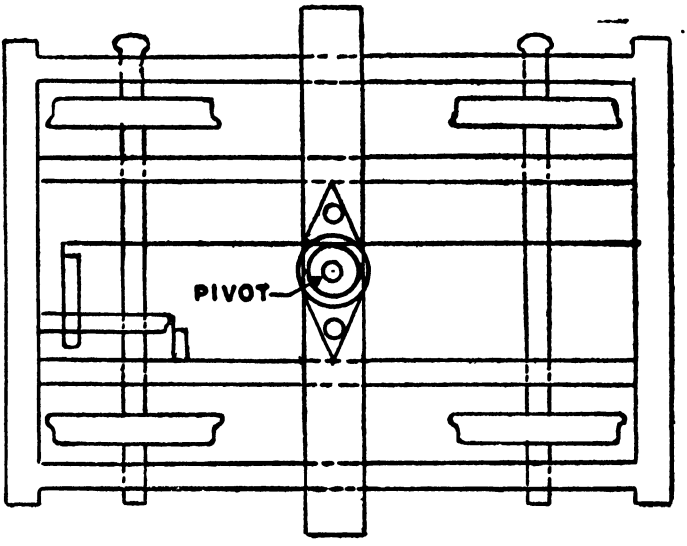
There are four wheeled carriages and wagons as well as bogie carriages and wagons and the latter are eight-wheeled or more. In the case of four-wheelers and six-wheelers the wheels are practically fixed to the bodies of the carriages and wagons or in other words, the upper bodies are mounted on axles and the movement of the wheels is to the extent of the space between the wheel flanges and the rails, and also there is a certain amount of play in the connection between the wheels and the frames of the carriages.

But in the case of 8 wheelers or bogies the upper frame that is the carriage or wagon body is mounted at each end on a small truck. Each such small truck has two or more pairs of wheels placed close to one another, and there is a pivot on which the truck moves. Thus on a curve, owing to the distance between pair of wheels being small, the movement is

easy and the turning and movement is that of the small bogie trucks at each end (on which the carriages or wagons rest) and not of the upper body. Thus the lurching in the bogie carriages is not felt so much as in the case of four wheeled carriages. The arrangement of bogie wheels is somewhat the same as is the case with an ordinary four-wheeled horse Gharry where the front part of the carriage is supported on a pivot between the front pair of wheels.

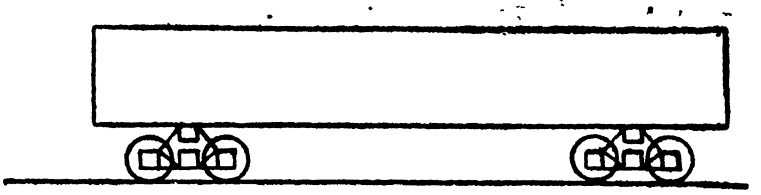
Rough diagrams shewing what is a small bogie truck, on which the carriage or wagon body is mounted is given in figure CC and the side view of a bogie carriage or wagon is given in figure CCA.

FIGURE C C.



In America, there is extensive use of bogie passenger coaches and bogie goods trucks and wagons.

FIGURE CC.A.



SIDE VIEW OF A CARRAIGE OR WAGON BODY ON BOGIE WHEELS

In India, there are now-a-days a large number of bogie coaches running on passenger and mail trains of most railways. In fact, except on branch lines or on small railways, four-wheeled passenger coaches are rare, and bogie carriages more common. But in the case of goods vehicles the reverse is the case.

Bogie wagons were first introduced in America in order to effect economy in cost of transportation, *i.e.*, mainly to increase the freight loads of trains by reducing the space between the wagons and by increasing the capacity per wagon. In a country like America, where transactions are made in large lots, where the number of wholesale dealers is very large, where the development of agricultural, mineral and industrial resources have been exceptionally great, where consignments are naturally tendered for despatch in large volumes and in great weights, the higher capacity wagons are very useful and economical. But in India while such wagons may be useful for traffic like coal, manganese and iron ores, and may thus suit say the B. N. Railway or the E. I. Railway it has been seen that large capacity wagons are not always economical for all railways. In this connection I would invite attention to facts and figures given on pages 541

and 542 of my Monograph on Indian Railway Rates and I will also deal with this point in my paper on. "Full wagon load traffic" later on.

Compared with America, India is a country of retail dealers and of small consignments, and besides in loading, unloading and moving vehicles at roadside stations, hand labour is mostly employed. Therefore, the introduction of bogie wagons of high capacity and heavy weights on an universal scale would not be very suitable; in fact in Southern India it would be difficult to get even fair loads for them, as there the traffic is mostly in vegetables, cocoanuts, paddy, etc. Moreover, the movement of traffic from villages to the railway stations in India is carried on by country carts over rough roads or no roads. And it takes about 20 carts to make up 500 maunds (the average load of a four-wheeled wagon) and it is therefore more easy to get full load for a four-wheeled wagon at a roadside station than for a high capacity bogie wagon. We want wagons for many years that would suit all traffic.

Suppose at a roadside station, there were 1,500 mds. of wheat waiting for despatch and they were in lots of 500 mds. each for three different stations. In that case, if three bogie wagons of say 800 mds. capacity each were employed, there would be a wastage of 300 mds. in the capacity of each wagon, whereas 3 four-wheeled wagons of 500 mds. capacity each would go fully loaded. In the ease of bogie wagons there will be wastage of capacity which must mean wastage of space in trains, which again implies more trains for the same weight of traffic—thus adding to the congestions at junctions, stations, terminals, etc., and also meaning more staff, more sidings and loop lines at stations for more trains but not with very big freight loads in them.

INDIAN RAILWAY TRANSPORT SERIES

No. 4.

METHOD OF DEALING WITH GOODS TRAFFIC

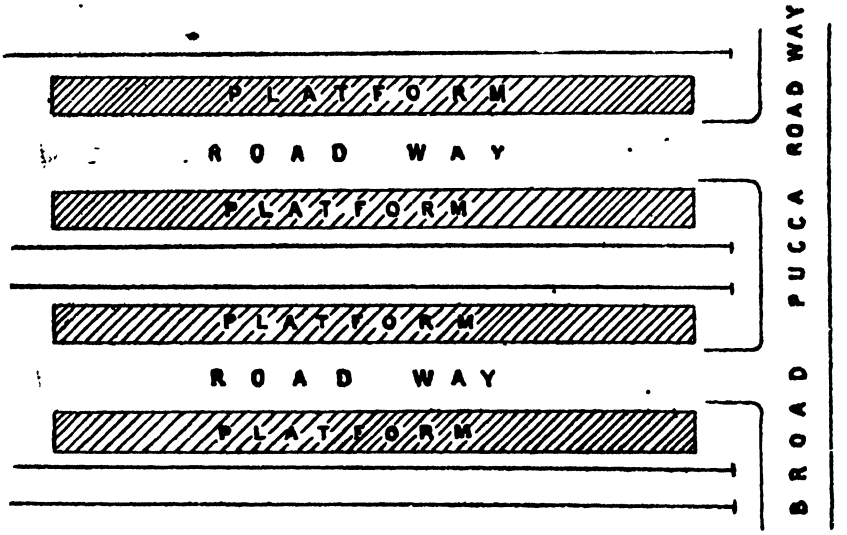
It is necessary to get the best out of wagons and rolling stock and for this purpose it is essential to strive to attain this from the very beginning.

Goods Sheds.

In England and in America, it is one of the important part of the business of the railways to collect goods and to bring them to the railway goods sheds in carts and also to deliver goods at the doors of consignees, but in India the railways have generally nothing to do with this portion of the work. Goods are brought to the stations by consignors in lorries, carts or by boats and are similarly removed by the consignees.

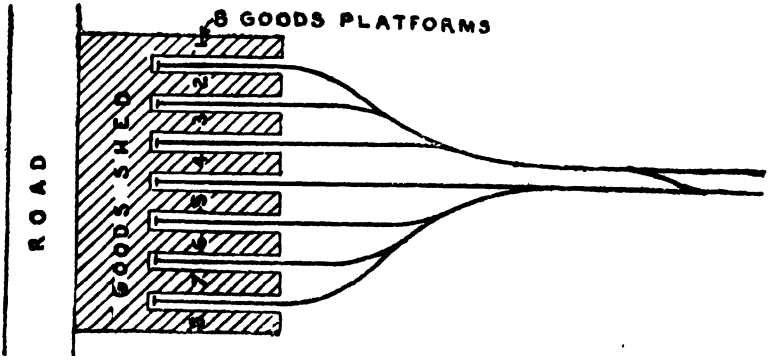
It is necessary that utmost facilities should be given for the ingress and egress of goods at goods sheds. The Railway terminals at various places, *e.g.*, at the ports or in big commercial towns differ in many ways. Some of them have one broad road for carts (both in and out) and the railway goods platforms (covered over by sheds) run at right angles from this road and on one side of the platform there are lines and on the other side there are roadways. (See Figure A.)

Fig. A.



Whereas in other cases there is also one broad roadway and goods shed (covered) alongside of it for receiving and despatching goods, and the platforms for loading into and unloading from wagons project from the main goods shed platform and the railway lines are in between two platforms. With this arrangement, the platform (or a part of it) on one side of the line may be used for unloading and the platform (or half the platform) on the other side for loading with outward goods, after the goods received in the wagons have been unloaded, and this saves shunting of wagons from the receiving or unloading lines to the outward or loading lines. (See Figure B.)

Fig. B.



In both the above cases it is best to allow certain bays or certain portions of each platform on the loading side for goods for certain groups of stations so as to facilitate loading and despatch of traffic.

Fig. C.

In order to economise space and particularly to enable each wagon or two, three or more wagons being cleared away as soon as they are loaded (instead of their having to wait till the whole string of wagons on a platform line is loaded up) saw-shaped platforms have been considered useful. They take the shape given in Figure C.

When the traffic of a railway is such as would require for a platform a number of wagons that could be loaded and despatched by one train then goods platforms of types shewn in Figures A and B are useful, but when wagons are for various places and are to be formed into trains in a separate despatch yard, in that case platforms of type shewn in Figure C are useful.

At big terminals, wagons for outward traffic are supplied from those released from inward traffic, but as the number of wagons unloaded at big terminals at the ports is generally greater than those required to be loaded, a number of them have to be worked away to the sorting and despatching yards empty for formation of trains and only the number required for outward loading is placed on outward lines and sheds by engines. In such cases saw-shaped unloading platforms are useful as they help clearing of wagons as soon as they are released from the unloading sheds.

Goods Traffic (outwards).

Ivatt, in his Railway Management at Stations, says that the collection, loading, invoicing, and despatch of goods constitute one of the most important branches of railway business and adds that upon the perfection with which these several operations are performed greatly depend the quickness of transit from sender to consignee. The outwards goods acceptance department precedes everything else. In the first place, a great deal depends upon accommodation in the way of road space for carts, platforms space for stacking, and facilities for weighing, marking and sorting before goods can be placed in position for loading.

On weighment of goods being done and the forwarding note written by the sender the railway receipt is made out, and as the railway receipt and the invoice are but copies of one another they are made out simultaneously with the assistance of carbon paper and there remains an office copy in the way of "counterfoil." The railway rates and charges, the description of goods, weight and marks are all entered on the receipt. The receipt is handed over to the consignor and *now the goods can be taken over for loading.*

The correct tallying of goods when being loaded, the accuracy of details on the card labels and wagon way bills, the keeping together of all packages of a consignment and for a particular station are chief essentials in the art of loading and making up of wagons.

Goods in bulk, such as stone, bricks, and bulky goods such as timber, bamboos, rafters, boilers, long pieces of iron are generally loaded from separate platforms and the conditions of rates charged for such traffic may require that they should be loaded and unloaded by the senders and consignees, respectively. In such cases, there is always the danger of wagons being overloaded by senders, and when there are no weighbridges or carriage examining staff the station staff should be able, to a certain extent, to detect any overloading by examining the wagon springs and seeing whether they are unduly depressed or flattened, and comparing it with the springs of other loaded wagons.

Small Consignments.

The loading of goods in order to attain full wagon loads is aimed at by railways, but the conditions of merchandise traffic, except in the case of coal, iron, manganese, stone, lime and other minerals, grain and seeds, involve carriage of consignments in small lots between places, where wagon load traffic is not regular, and for the carriage of such traffic either van goods trains or tranship wagons are used.

The Indian Railways, in addition to having small packages of merchandise to carry to and from large centres, possess a large number of small stations, which cannot afford traffic in full wagon loads. Consignments of less than wagon loads may be booked to and from such stations and require transhipment and handling several times, between stations of origin and destination. I will deal with "smalls" first, and wagon loads afterwards.

In the olden days, tranship wagons known as "Through Road Vans" were in common use on all Indian Railways and used to be booked through from one railway to another. Generally terminal stations, such as Calcutta, Bombay made up vans for a junction, important station or a centre containing odd packages for junctions, or important places and for places beyond. The junctions, important stations or central stations, in their turn, made up fresh vans for next centre or junction stations or important places and from these places packages for small stations nearest to them used to be sent out in charge of guards of sectional pick-up goods trains, as "road van packages," in wagons, which were utilised for setting down and picking up packages *en route* at and from small stations, the loading and unloading being done by station porters.

Through Road Van or Transhipment Van Trains for Smalls.

The knowledge of the loaders at terminals, junctions, centres, (rather repacking) stations, etc., in making up a van for each advance centre in such a manner as to put into the van packages for places that would be served most quickly and directly from that centre, to which the van was being loaded, was most essential. The loader was required to possess knowledge not only of the situation of stations on his own line but on foreign lines also, for instance, an E. I. Railway loader at Howrah was required to know which stations on the O. and R. Railway would be best served by Lucknow and which stations from Bareilly or Shahjahanpur or similarly which N.-W. R. stations could be served by Lahore, and which from Ludhiana.

Gradually, the system was improved upon, and "van goods trains," to deal with small consignments, were started by every important railway. Some railways describe the van goods trains as "tranship goods trains."

These trains generally run from and to terminals such as Calcutta, Karachi, Bombay, Delhi, and supplementary trains, in connection with the main line van goods train service run over branches or on connected railways from and to junctions.

Van goods trains consist of a number of vehicles, which may be 35 or 40 or less or more according to requirements and accommodation at stations in dealing with them and generally consist of—

(*a*) Through vans for repacking stations, which are practically the old tranship wagons or through road vans.

(*b*) Junction vans, which may contain goods for foreign railways *viâ* a junction and also for local stations beyond the junction. These vans are given full loads, if available.

(*c*) Vans for important stations, which can be given a load of say 50, 81 or 100 maunds and sent direct to such stations.

(*d*) A number of wagons to clear local station to station traffic.

These vans are allotted a certain number of stations, *i.e.*, goods from such stations only can be put into these vans, but this leads, in some cases, to goods for one destination station being put in more than one van, and, therefore, wherever the halts are long enough or when detentions occur for crossing of trains, etc., at a platform station, the van goods clerks, with the aid of porters are supposed to tranship and reload so as to collect goods for one station in one van only, as far as practicable.

The junction vans, however, did not prevent running of through vans over two or more railways. Between the E. I., R. and O. and R., G. I. P., and the North-Western Railways there existed an arrangement under which traffic from one station

on one railway to one station on another railway weighing 50 maunds or 81·6 maunds (in some cases), made up of small consignments, could be sent in a wagon direct to destination, and generally the van goods trains were relieved of such wagons, which went by through goods trains.

The van goods trains are accompanied by guards, van goods clerks and porters, who are allowed to rest in rest vans on the train when not on duty. The staff for each van goods train, as may be required for the whole run, travel with the train and have allotted hours of duty. But when there are heavy packages the station, to which the package or packages are to be delivered, are wired ahead to be ready with their porters to assist the train porters.

Goods Traffic (inwards).

At a terminal station it is of utmost importance that before wagons are shunted into the different warehouses, wharves or sidings for unloading and delivery, the wagons should be sorted, *e.g.*, for coal wharves, mineral wharves, grain warehouses, miscellaneous sheds, mills, cattle unloading platforms, etc., and wagons should not be sent out from the yard in greater numbers than could be accommodated in the various sidings.

There are usually reception and sorting yards at terminals, where trains are received, and there they are broken and wagons sorted for various warehouses, sheds, sidings, etc.

The staff in these yards are required to have a thorough knowledge of the position of the various sidings, wharves, etc., the number of wagons they will hold, and also if any of the sidings are blocked or not so that when wagons are sent they can easily get through from the sorting yards to the particular sheds or sidings. A great portion of this work, including placing of wagons into sidings has to be finished before day's work starts in the morning.

Then the wagons (when placed in position for unloading) have to be released as soon as possible, and for this purpose, unloaders, tally clerks and labour for unloading, etc., have to be

on the platforms in due time. The unloading operation depends on the room available on the platforms, and it is essential to keep each consignment together for conveniences of delivery. When the unloading platforms are with limited accommodation and there is difficulty in carting goods away the wagons suffer detention. The merchants, unless there is urgent demand for goods, take full advantage of the free time allowed without demurrage being charged, and this is one of the reasons why during recent years the railway authorities have been compelled to curtail the free time and to increase the rate for demurrage at some places.

Immediately a wagon arrives in a shed, the first business is to remove the seals and then to tally the goods, during the process of unloading, and it is not advisable for more than one checker totally the goods of one wagon.

From the unloading platform the goods are generally carted away by the consignees, but at certain terminals (say at Howrah) there are rented warehouses at the railway terminus, and goods for consignees (who have rented plots in these railway warehouses) are unloaded in such sheds.

Moreover, there are mill siding and godown deliveries in Ramkristopur (Howrah); in Calcutta and Bombay (through Port Commissioners' lines), in Karachi (by the railway and also by the Port Commissioners) and at many other places, like Cawnpur, the suburbs of Calcutta. This involves considerable amount of shunting; at some places one siding serves many godowns or mills. Godown or mill delivery requires wagons for each trip to be so arranged as to take every godown or mill in order, but here again, like colliery wagons, loaded wagons have to be removed before empty wagons can be placed in; at some places, a separate engine comes in at a certain hour to take loaded wagons away, but when wagons are not unloaded soon after they have been placed into sidings, then the engine that comes in with loaded wagons, during the day, first detaches its load, places it on a separate line and then picks up the empties and places them on another line, and afterwards places the loaded wagons at the doors of

respective godowns. The charges paid by the consignees for such work is not commensurate with the work that has to be done and the delays, which these deliveries cause to wagons, but as a railway considers such work part of its duty in order to advance its business it undertakes the work without much extra charge.

The goods unloaded on platforms are necessary to be sorted at once so that two or more consignments do not get mixed up, or that goods previously unloaded may not be covered by goods unloaded later on, and it is essential that packages should be so arranged that they can be readily found when wanted for delivery or checking at the time of closing the sheds after each day's work.

INDIAN RAILWAY TRANSPORT SERIES

No. 5

FORMATION, MARSHALLING AND DESPATCH OF GOODS TRAINS AND YARD WORK

At large terminal stations, when the terminal yard deals with both mineral and merchandise traffic (inwards), it has got to return wagons to the mineral districts (generally coal districts in Bengal and Behar) in full-train loads of empty wagons to different coal-despatching centres, and also to grain-despatching stations.

In the same way as the coal loading districts have to collect wagons from various collieries, the terminal has to collect empty wagons and loaded vehicles from various sheds, wharves, sidings, river delivery lines and coal depôts, godowns, mills, etc.

The making up of a train is an art, which requires a considerable amount of experience, foresight and knowledge of conditions ahead. Marshalling of wagons for each train in station order is very important, *but where such marshalling should be done is a matter dependent on facilities.*

The facility with which trains can detach wagons *en route*, with the minimum of shunting is of immense importance, and, therefore, experience has led to the arrangement of wagons on a goods train to be in the same order as stations stand in the course of the journey. That is, the wagons that are put together next to the engine are those which are to be detached at the next stopping station and so on. By this arrangement wagons may be thrown off quickly by one shunting operation. This is generally known on railways as "marshalling of trains." Each individual railway does marshal trains on this principle. A train of coal wagons for the G. I. P. Railway *viâ* Delhi could be started from the coal fields with traffic to G. I. P. Railway stations alone if there were a sufficient number of wagons

loaded with coal for the G. I. P. Railway to make up a train load; otherwise there may be run a train of mixed wagons for the G. I. P. Railway and the North Western Railway up to Delhi. *For years one idea prevalent in my mind was that even if by detaining wagons, say at Sitarampur, Asansol, or Dhanbaid on the E. I. Railway and Adra on the B. N. Railway for a day or two, a full train-load of wagons for say the N.-W. Railway beyond Delhi on the G. I. P. Railway so on for other railways could be made up and the wagons on the train marshalled in proper station order on the G. I. P. Railway or the N.-W. Railway, as the case may be, it would effect economy in the long run, and there would be advantage gained in turning wagons round quickly.* The cases *vid* Delhi are merely quoted as illustrations. Similarly, if the O. and R. Railway brought into Moghalserai trains consisting of wagons for Kidderpore Docks only, and for Howrah alone, it would save detentions to wagons *en route*.

The idea of detaining loads to get through loads is not new. If coal wagons, say for the N.-W. Railway or the B. B. & C. I. Railway or G. I. P. Railway, can be detained at say Moghalserai on the E. I. Railway or at Chakradharpore or Bilaspur on the B.-N. Railway to make up through train loads for say Lahore, Karachi, Ahmedabad, Bombay, etc., it will pay to afford facilities to detain such wagons by construction of sidings for the purpose in large yards. Droege, a well known American Railroad man, in his valuable work "Freight Terminals and Trains" writes as follows:—

"It is a very good general proposition to make up as many straight trains to distant points as can be assembled within a reasonable period of time. These trains should be made up solid for points as far distant as practicable. A general rule, under which cars are held for a solid train for any point to which there are sufficient cars to make up such a train every 24 hours, has worked out successfully on one road. In many instances, freight would be more expeditiously handled by holding 48 hours, or even longer.....Holding the cars at the original

terminals for this purpose keeps them out of many intermediate yards and saves extra handling."

The coal districts of one railway (E. I. R.) deal with daily a very large number of wagons say 4,000 (including loaded and empty) and there are yet not adequate facilities for handling these. The practice of getting trains out of terminals (or *changing stations*), as a matter of convenience to that particular terminal without regard to the inconveniece of forward changing stations and delay to traffic cannot be considered too severely. There are however, cases, where the facilities of one changing station are so inadequate that a part of its work must be shifted to forward changing stations.

The results to be attained are

(1) first to make up trains for one single destination,

(2) failing which attempts should be made to form trains with wagons so arranged as to run trains to the furthest breaking point, *i.e.*, as near the destination as possible. In this matter the object should *not* be to get the trains through over each railway alone. The bulk of the Indian Railway traffic is *through* traffic and as every railway (over which the traffic passes) on the same gauge is interested in turning round wagons quickly the endeavour of railways should be to help each other by marshalling being done for foreign lines as well. For this purpose a map showing every station, and a book with an index showing each station in alphabetical order and then giving reference against each station name to the page on which such station may be shown in station order over each railway, branch, or section should be available at every changing station yard. When on the E. I. Railway I had prepared such a book for the Coal District (Route Table).

The first object to be aimed at is to so arrange trains from one end to another over each railway as to avoid detentions at changing stations.

On some railways, a few years ago, sectional goods trains used to constitute the bulk of the goods trains run on those railways. The first object with a goods train time table should be to avoid detentions at roadside and changing stations, and some of the through trains to be so arranged over one section as to fit in with the trains of the sections on either side, in order that through wagons do not suffer detention for want of trains when they arrive at the end of one section.

Through goods trains may be detained at a changing station, if they are not full-load trains, for the purposes of giving loads to them, and for this purpose it is essential to get wagons ready for them in changing station yards, and to so place them that they can be attached to the incoming through trains, with minimum of shunting.

Each train leaving a terminal junction or changing station should have a full load if possible.

Unless special work or pick-up trains are utilised for road-side station traffic it means that all goods trains must do the work of detaching and attaching wagons as they move on (detaching empties for loading, attaching loaded wagons and at some stations pickiug up empty wagons also, that have discharged their load and have no return traffic).

Thus every sectional goods train becomes a pick-up train and, consequently, there must be detentions on the road. Therefore, it was recognised that each section ought to utilise at least one pick-up train from each direction. These trains may run from one end of the section to the other, their business being confined to supplying empties (avoiding, of course, cross movement of empties) and picking up loaded wagons for the direction, in which the pick-up trains are running or to picking of empties alone, if the run be in the direction in which a large number of empties are to be sent. The loads taken by such trains to the forward "changing station" would assist that station in mal ing up train for onward journey and it is thereby that detentions to through trains can be avoided.

On some railways, a through train may start with less than a full load and pick up wagons *en route* for the destination to which it is running. In such cases, however, the through train, until it gets a full load, may suffer detention *en route* or run with light loads for some distance—once, of course, it gets the full load it can run through. But such cases in these days ought to be rare.

Excepting in the case of pick-up trains, all other trains should be run, as far as possible, with the object of clearing wagons for as long distances as possible; if wagons for a full train for one particular destination cannot be had in a day it would be better for a terminal or a changing station to have a full load by keeping back wagons for a day or two; of course there is the danger of congesting a particular yard in this manner. But, however, where through trains are run on main lines they are generally (1) either to a port or (2) to a big station or (3) to a forward changing station *en route* to a port, (4) or to a coal field, and thus on a big railway a through train is generally made up. As the trend of the traffic is in the direction of ports, and as almost every station has some traffic for a port such traffic can be picked up by pick-up trains, and the next forward changing station can join them and from through trains from the wagons brought by pick-up trains.

A through train can leave a terminal with a fair through load (it may not be full), if it expects to make up full load before it arrives at the next changing station; in that case, there would be no harm in such a train starting from the terminal station with a load in the rear, for the final destination, and with wagons in the front in station order for *such* intermediate stations where it would pick up loads for its final destination. This must be a matter for good arrangement, because the starting station must know exactly where load can be picked up *en route*, for purpose of the through train, so that wagons for such stations *only* might be attached to

the through trains from the starting station, in order to give the through train a fair load to start with.

When a train consists of both loaded and empties the general practice recommended is to keep the loaded in the front and the empties in the rear as it is claimed that train resistance is greater when reverse is done. It is also stated that "the wheel flange friction on the curves is increased when the loaded are in the rear owing to the major portion of the train weight being placed further away from the locomotive."

Changing Station Yards and some idea of Yard Work.

There are several reasons for detentions to trains in yards, and in many cases the detentions are more than the time taken in getting through a section ahead The acceptance of incoming trains and the starting of outgoing trains are important factors and, in some cases, it is essential to keep connection between the two.

If "through goods trains" contain full complement of wagons for places beyond the section they ought not to suffer detention in changing station yards, unless there is shortage of locomotives or the section ahead is unable to receive the train.

Even in dealing with through goods trains, first in and first out is not the principle, which regulates their movements in and out of big yards at changing stations. Trains are generally regulated and given precedence according to their importance. Quick transit traffic trains must, of course, have first precedence and then come in trains, which consist of wagons for the longest distance, and next trains with wagons for shorter distances.

Almost every yard differs from the other, and it is difficult to discuss any particular yard that will be generally useful. Yards have grown up with the traffic, and most yards were

designed when the traffic was nothing like what it is at present or what they have since been required to deal with.

Nevertheless it may perhaps be useful to give some general idea of what a goods yard is.

Goods Yards.

A yard is a machinery for receiving, sorting and despatching trains and wagons to or in the direction of their destinations, and endeavours should be made in designing and in working yards in a manner that all these operations are facilitated and quickened.

In the beginning, it is essential that goods trains should be removed from the main line with the least possible delay so as to make rooms for following trains.

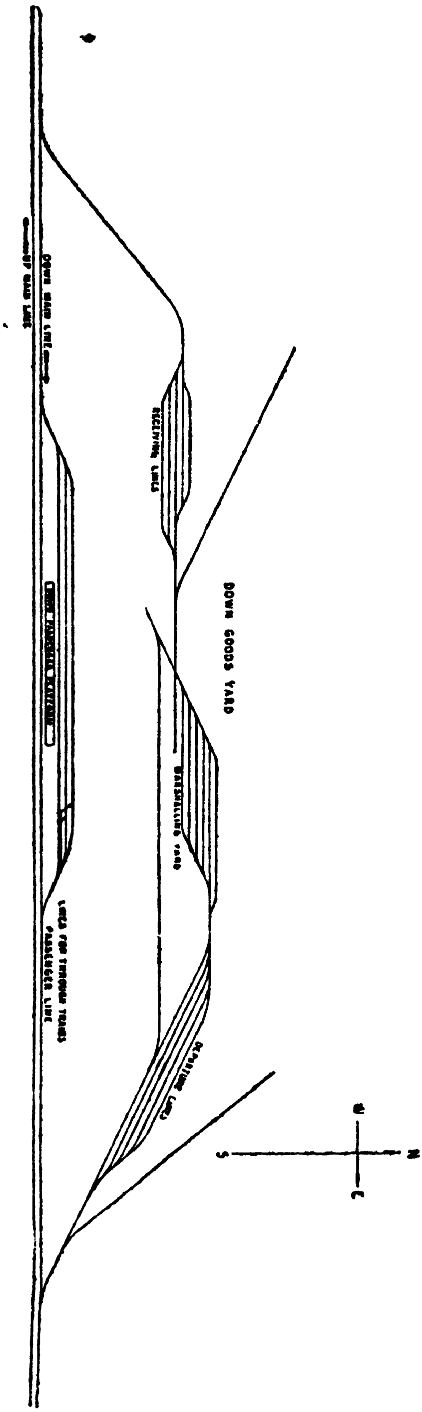
Therefore, goods trains should be taken to the reception lines (excepting such goods trains as are running through and are only waiting for the change of engines). For such through trains one or two lines may be set apart in the station yard, but clear of the passenger lines.

From the receiving lines the goods trains go to the sorting and marshalling lines.

These marshalling lines are in the form of spikes or are double-ended that is, that at each end they converge on to one gathering line. The object of this is to enable wagons to be taken out or put in by engines from both sides. See Sketch D below.

A few yards have been so made that the work of putting in wagons from the receiving end of the marshalling lines to the marshalling lines is done by gravitation. An artificial Hump is created at a convenient point between the receiving and the marshalling lines. The grade therefrom to the marshalling lines is made such as to cause the wagons to roll by force of gravity to any of the marshalling lines, and the distance from the hump to the marshalling lines depends on the topography of the ground. See Sketch DDD.

Sketch D.



Sketch DD.

SIMILAR ARRANGEMENT CAN BE MADE ON THIS SIDE FOR BOTH PASSENGER AND GOODS LINES FOR UP TRAINS; THE DIFFERENCE WILL BE ONLY THIS—THE RECEIVING LINES WILL BE ON THE EAST AND THE DEPARTURE LINES ON THE WEST, AND IF THE "MARSHALLING YARD" BE A GRAVITY YARD IT MAY BE TAKE THE FOLLOWING SHAPE OR ALSO THE SHAPE GIVEN BELOW:—

In the marshalling lines the wagons received are sorted and arranged in station order or are grouped together for one station or a centre or a junction so as to facilitate their quick transit onwards (*e.g.*, Bombay wagons may be put in on one line, Ahmedabad wagons on the other or all wagons for one railway *viâ* one junction, say for Delhi Junction for the N. W. Railway, on another line; or wagons for stations on the length say from Cawnpore to Tundla on the E. I. Railway may be arranged on an Up goods train, starting from say Cawnpore yard, in the order of stations, that would come first, second, third, fourth and so on, and their order of placements on the train will be in this order from the engine, *i.e.*, wagons for the station that would be reached first after leaving Cawnpore in the Tundla direction will be next to the engine and then wagons for the second station and so on).

Shunting by gravitation in a gravity yard enables an engine to send wagons from the Hump to the marshalling or sorting lines quicker than when engines are required to place wagons on each of the marshalling lines and to come out again and go back with more wagons all the time. These operations are rendered unnecessary in a gravity yard. The engine pushes the wagons from the receiving lines and drops (or sends) them down the hump to the marshalling lines by simply detaching them.

The design of a yard at a place depends to no small extent on topographical conditions.

It is essential that the engine shed and the lines for the engines to go out and come in should be convenient.

For purposes of facility of dealing with trains and wagons it is held by some that the Up yard should possibly be on the Up side, and the Down yard on the down side. But it is neither economical nor very practicable to have two engine sheds, *i. e.*, one on the Up side and the other on the Down side, because apart from the point of double set of sheds, workshops, machinery, staff, etc., it is to be noted that engines must run in

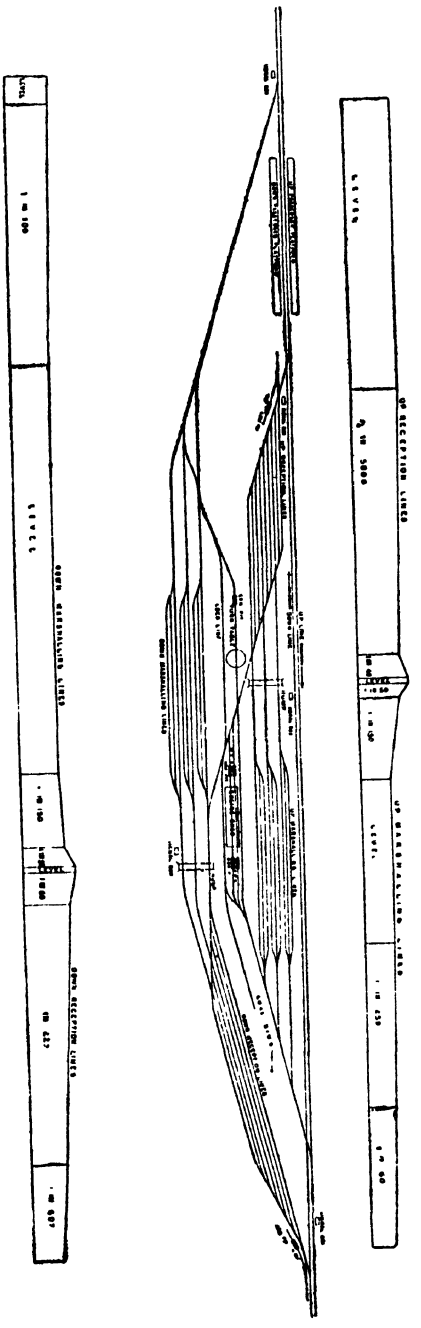
both directions and thus an engine coming in with an Up train has to go back either with a Down train or to run back empty.

[NOTE.—When empty trains run in one direction and loaded trains on the other, the number of trains and engines required to bring back the empty wagons are naturally less than required to haul the same number of loaded wagons. Hence engines and trains in the direction in which loaded wagons go are greater in number. Therefore, the engines in excess of those required to haul empty wagons back are returned by themselves or light.]

Therefore, engines going in and coming out of engine sheds have to cross Up line or Down line as the case may be on each trip when the engine shed is on one side, but this cannot be avoided in all cases, but it should be seen that the lines for entrance and exit of engines are convenient and also that the crossings are such as do not interfere with the work on the several lines, as far as possible, and do not endanger safety. This depends on local conditions, and separate methods and plans have to be devised in each case.

The most convenient place for an engine shed is the centre of a yard with Down and Up yards on the north and south of it. A rough sketch map of such a yard is given in sketch No. DDD, which shews Up and Down main lines, Up and Down goods reception lines, Up and Down marshalling lines (from which trains could start as they are ready after being marshalled), the engine shed in the centre, ash pits, exit and entrance lines for the engines, the position of signal boxes, places for stacking coal required by engines. And also the grades of the rise from the reception lines to the Hump and of the fall therefrom to the marshalling lines have been shewn in order to illustrate a gravity yard.

Sketch DDD.



In a gravity yard there is a rise from the reception lines to the summit of the artificial Hump, and then a fall from the Hump to the marshalling lines, which are generally on a level, but the lines on both sides of the marshalling lines are on a grade so that wagons do not roll on further than the marshalling lines.

Gravity yards are however but a few in India, and in most yards the work of placing, sorting, marshalling, taking out of wagons is done by shunting engines.

For purposes of making improvements in yards and in yard working, it is considered necessary to

(1) ascertain the number of trains to and from each direction daily;

(2) separate the numbers that run through from numbers that are broken, made up again and started as fresh trains to all intents and purposes;

(3) in respect of trains dealt with in the yard (*i.e.*, which did not run through) ascertain the number of wagons brought in and taken by each;

(4) It may be well in respect of both (2) and (3) to go into greater details and find out the number of wagons on each train for one destination, for separte terminals, centres and junctions.

(5) Then add together the number of *wagons* for 1 or 2 days,
for one distinction (whether local or foreign),
for one junction,
for one terminal or changing station,
for each different section.

(6) Next find out
(*a*) what detentions eaeh through train suffered and why,
(*b*) whether the number of trains could be reduced by detaining wagons and starting through trains for long sections for one destination or for one junction with foreign lines, etc.

After having done this it will be useful to find out

(7) whether it would be convenient to do the sorting and formation of through trains (and of how many of them and in respect of which wagons) either in the particular yard under discussion or in a yard ahead or behind.

(8) what extra accommodation and in what direction such accommodation is needed for trains and wagons for each direction (up and down) in receiving, separating sorting, or marshalling and departure yards.

INDIAN RAILWAY TRANSPORT SERIES

No. 7

FULL WAGON LOAD TRAFFIC AND WAGON DISTRIBUTION

"Full wagon load" traffic on all railways in India cannot be generally considered in the same sense as the "car load traffic" of American lines, except in connection with coal and manganese and iron ores and partly in connection with wheat, seeds traffic of some railways, and also full pressed cotton in one case. In America, the business is largely done in big lots, and there are advantages in the matter of large quantities of car load traffic being offered to railways for carriage. It has paid the American lines to considerably increase their wagon and train capacity and corresponding siding and station accommodation to deal with big wagons and big trains, as it is considered that heavy load is most desirable for economical operation, but when the wagon capacity is increased and the load per wagon does not increase correspondingly it means adding to the dead weight of trains, which is not economical working.

For railways like the East Indian and the Bengal-Nagpur, whose principal traffic is coal, high tonnage wagons are useful in sending away wagons and trains of concentrated loads; the results of the O. and R. Railway with grain traffic outwards and coal traffic inwards, are also good in the matter of load per loaded wagon; but for the big grain-carrying lines such as the North-Western, the B. B. & C. I. and the G. I. P. Railways the existence of a large number of wagons of high capacity has not been found to assist in big loads per wagon being secured all round.

Taking the year 1916-17 the average carrying capacity of wagons on the following railways was as follows:—

	Covered wagons. Tonnage (average).	Open wagons. Tonnage (average).
B. N. R.	16·26	18·32
B. B. & C. I. R.	18·98	19·27
E. I. R.	18·40	16 77
G. I. P. R.	18·34	16·56
N.-W. R.	21·38	17·63

Whereas the average load per "*loaded vehicle*" was as follows for 1916-17—

	1st half.	2nd half.
B. N. R.	14·59	14·22
B. B. & C. I. R.	12·24	12·07
E. I. R.	13·50	13·29
G. I. P. R.	10·91	12·44
N.-W. R.	11·23	13·12

Taking even more recent figures of 1920-21 the average capacities of wagons were as under, as compared to this average load of a loaded vehicle.

Average load of a loaded wagon. Tons.		Average capacity in tons	
		Covered wagons.	Open wagons.
15·34	B. N. R. ...	18·15	20·49
11·85	B. B. & C. I. R. ...	19·37	19·18
6·85	E. B. S. R. ...	16·68	17·70
14·00	E. I. R. ...	18·66	17·33
13·29	G. I. P. R. ...	18·20	17·12
10·96	M. S. M. ...	18·61	17·09
14·75	N. W. R. ...	21·44	16·90
18·50	O. & R. R. ...	18·55	13·40
11·36	S. I. R. ...	18 52	19·05

These figures are very interetsing. The O. & R. Ry. got the best loads for its wagons, and its working expenses, *i.e.*, the cost of hauling one ton one mile was also low, as shown in lecture No. X on railway economics; of course not so low as of the E. I. R. or of the B. N. R. who have the advantage of cheap fuel because of their nearness to the coal fields. The B. N. Ry. loads were the next best, because of its coal, iron and manganese ore traffic. The N.-W. Ry. stood third, owing to its heavy grain traffic, the E. I. Ry. came fourth and the G. I. P. fifth. Except in the case of O. & R. R., it is seen that compared with the average carrying capacity the average load was much smaller. For instance the deficit on B. N. Ry. was $2\frac{1}{2}$ to $4\frac{1}{2}$ tons per wagon; on the E. I. R. $3\frac{1}{3}$ to $4\frac{1}{2}$ tons per wagon, on the G. I. P. Ry. 4 to 5 tons per wagon, on theN.-W. Ry. 7 tons in the case of covered wagons, which con- stitute the largest number of this railway's wagons. Others were worse.

Thus, the difference between the carrying capacities and loads was great. It is true high capacity wagons assist in securing better train and wagon loads, but unless the freight load generally secured per wagon is such as to take the best advantage of high capacity wagons it must mean wastage of transportation by adding more to the "dead weight" of trains. The East Indian Railway, for a number of years, stuck to their wagon load condition in the matter of grain rates and had lower rates for full wagon loads and higher rates for smalls, but finding that in competition with the G. I. P., B. B. & C. I., and the N.-W. Railways the E. I. R. were placed at a disadvantage in the matter of getting traffic to Calcutta as against Bombay and Kurrachee they (the E. I. Railway) also had to withdraw their wagon load condition from the special rates for grain and seeds on their own line from stations further up beyond Moghalserai, from the O. & R. Railway and the B. & N.-W. Railway to Calcutta.

Then, again, the East Indian Railway for a long time tried to fix rates from the B. & N.-W. Railway to Calcutta on a minimum of 30 tons per consignment or multiples thereof in order to secure good loads for both B. & N.-W. Railway

(metre gauge) and E. I. Railway (broad gauge) wagon as *30* tons would mean 2 broad gauge wagons (15 ton load for each) and 3 metre gauge wagons (10 ton load for each), but it was found that it was not easy to get such a big consignment at one station at a time, and the 30 ton condition was withdrawn.

Distribution of Wagons

The chief essential point in the matter of distribution of wagons is to find out exactly where empties are needed and how best they can be supplied. Naturally, one central authority controls all wagons on one railway and he allots or distributes certain number of wagons to each district or division and leaves it to the district officers to do the best they can for each district. The District Officers get daily station reports from each station showing the empties on hand and the goods ready or expected for despatch, but in this respect it is essential that information regarding the destination of such goods, the weight and their description and also as to the wagons that are expected (*viâ* different routes) should be given; this latter information can be had from the inward invoices, which are received previous to arrival of goods. This latter information would assist in an economic distribution (for instance if there be grain awaiting despatch at an E. I. R., or O. & R. Railway station to Bombay and inward traffic in full wagons is expected from Bombay in G. I. P. Railway wagons then it would be advisable even to wait for two or three days for the arrival of such wagons, especially in times of wagon scarcity).*

The inward traffic is generally small at grain despatching stations where the outward traffic is big and, therefore, inward wagons will not suffice for outward traffic, but in some cases there are trains passing stations, having traffic for despatch, with empties; in such cases the point is where these empties are going to and whether they could be utilised.

If the empties are going in the direction in which the traffic is to be despatched then the consideration is what proportion

* With the pooling of wagons this is now not so essential.

of such empties can be intercepted and utilised. Empties are generally moving to the point, where the demand for them is great (*e.g.*, empties from north move towards Bengal to the coal fields and from the ports to the produce-despatching districts). Coal districts in Bengal and Behar require certain number of empties for daily loading and they have to be supplied. In times the demand for them is urgent and for traffic of material importance, for say coal for railways, industries, but, under ordinary conditions, when traffic is awaiting despatch in the direction the empties are moving it is essential that as many of them should be sent loaded as possible, as it is only fair to the railway and to the public taken as a whole that empties should not pass a station, where traffic is awaiting despatch for the same direction in which the wagons are going empty.

It has been remarked that it is essential that the District Officer should have a fairly accurate knowledge of the kind of traffic dealt with at different stations, the usual number of wagons arriving and the tendency of outward traffic dealt with at different stations. In the distribution of wagons the knowledge of the traffic of particular stations is useful, and if this knowledge is combined with the movement of wagons on the entire district and on districts on both sides it would be more useful.

On each railway in India the chief wagon distributing officer with such a large amount of interchanged long distance traffic between railways, should have full knowledge of

(1) traffic of every section on the line,

(2) the flow of local traffic,

(3) the flow of through traffic,

(4) empties on hand on the line and where,

(5) empties away on foreign lines *viâ* different junctions,

(6) probable number of empties expected back, when and at which junctions.

So that not only the distribution can be so arranged that the empty wagons are not hauled for long distances

unnecessarily and go past traffic awaiting empties and do not cross one another, but the calls on foreign lines where wagons are away may be made for empty wagons (when foreign lines have excess balance against them) in a manner that will not overwhelm a railway with empties at one time so as to cause a block of empties. (See Indian Railway Conference Regulations about equalization of stock interchanged regarding calls for wagons on foreign lines.)

In these connections we have now the pooling of wagons of broad gauge railways in operation, under a Director of wagon interchange, and this matter will be discussed further in a subsequent chapter.

INDIAN RAILWAY TRANSPORT SERIES

No. 8

WORK INVOLVED IN COLLIERY DISTRICTS IN BENGAL AND BEHAR IN DISTRIBUTING, LOADING AND DESPATCH OF WAGONS

The distribution of wagons in a colliery district is an organisation by itself, and the existence of a large number of small collieries, which it has been the policy of the railways to encourage by sidings, makes matters most complicated and difficult. The sidings, in the Raniganj and Jherria coal fields are numerous, and there are loops, branches, and loops to loops and sidings to sidings. Pilot engines with empties run from each centre, such as Dhanbaid, Kusunda, Katrasgarh, Bhaga, Mulkera, Pathardih, etc., in charge of pilot guards, who have instructions to deliver so many empties at such and such a siding and each pilot is alloted a certain number of sidings or collieries. These pilots make more than one trip, *when practicable* and have to do a certain amount of shunting at each colliery, because while they have set down empties they have to pick up loaded wagons as well.

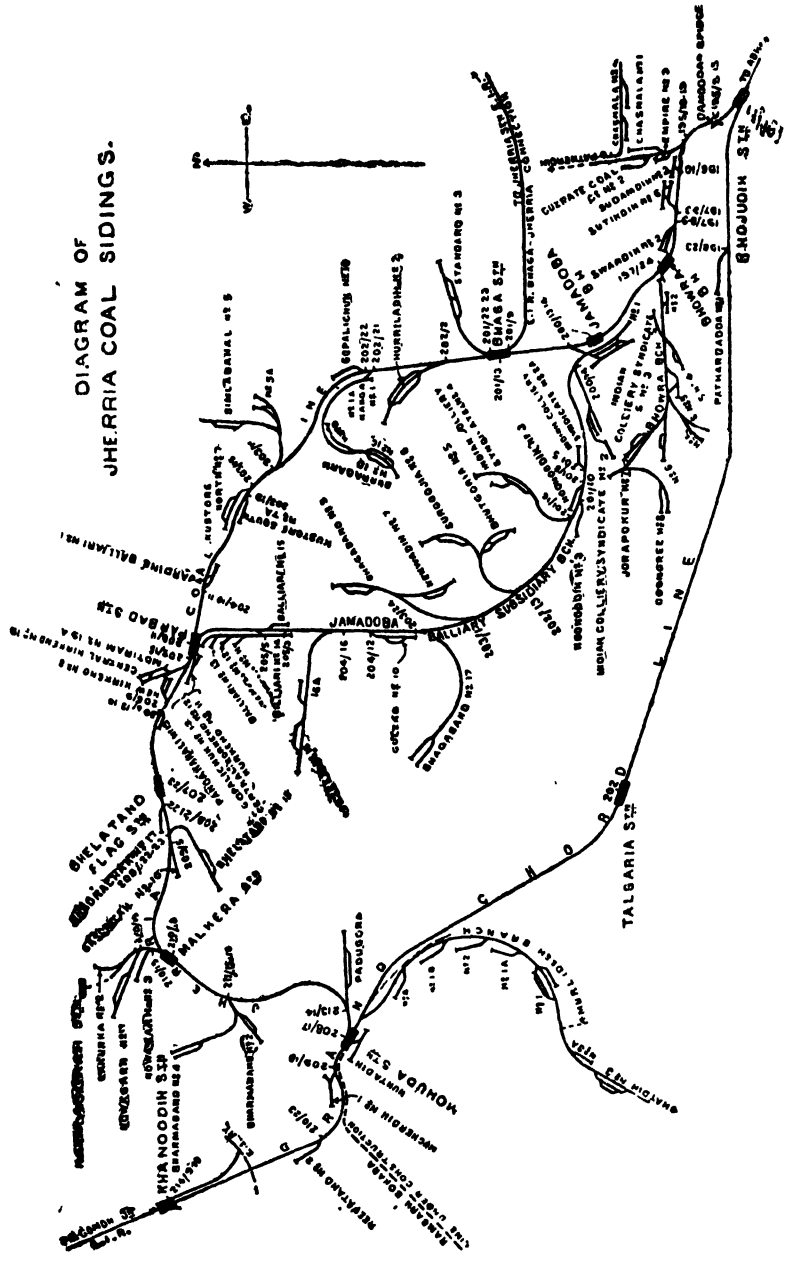
First the empty wagons are received in train load of empties at one or two places on each of the two railways in the coal fields wherefrom they have to be sent *to the* depots for various sidings, and then from the depots to the sidings direct or to sub-depôts. The wagons are in some cases, not loaded on the day they are put into the sidings. The loaded wagons have to be cleared by pilots, as already mentioned. Then, when loaded wagons arrive at different depôts by pilots they have to be weighed and sorted for various *directions* and then sent to train forming stations such as Dhanbaid, Adra, where they are marshalled and formed into trains. All this entails management, organization,

system, control, supervision and care to prevent blocks, detentions, mis-despatches, etc., and a complete record of wagon distribution to each colliery has to be kept. The *coal districts* of one railway load more than 2,000 wagons a day, which means that a similar number of empty wagons have to be handled every day so that more than 4,000 wagons are handled daily.

Where a colliery siding has a loop and a dead end siding this facilitates the work as shunting can be done on the colliery siding instead of blocking the main line of the branch or of the siding, which serves several collieries. But where these facilities do not exist the shunting has to be done on the main line of the branch or siding, which reduces the number of engines that can work on the branch. *Avoiding lines were provided at many places to facilitate the work where each colliery was not provided with a loop and a dead end.* Sometimes the engine taking out wagons to collieries is sent along *with* other engines in order that where there are several collieries on a siding the work of shunting, etc., could be done at more than one colliery at a time. (See Diagram ZZ for plan of a Colliery District Sidings.)

The correct labelling of coal wagons requires specially trained number-takers, because routes have to be shown, and the routing has to be in accordance with certain agreements, and the route, as shown in the book of route table, has got to be followed. The collieries label the wagons. In the case of foreign "Railway Coal" the instructions of the railway ordering the coal are followed and the colliery people are responsible for labelling, but in regard to "public coal" the routing has to be as arranged between railways, and the wagon number-takers have to examine the labels to see that the routing is correct. They must know the route settled for each station. As the number-takers in the yard have to act independently of the invoicing clerks both must have correct knowledge of routing. The label of each wagon has to be examined at the train-forming and despatching stations.

Diagram ZZ.



In connection with sorting and marshalling it has to be remembered that before the war no small amount of traffic was for the Calcutta direction. First of all wagons have to be

sorted between up and down trains and then down wagons say for the Docks, Shalimar, Howrah, Beliaghata, mill deliveries have all to be classified and marshalled. Some of the work of sorting and marshalling for down traffic is done in coal districts and partly (on the E. I. Railway) at Burdwan but as regards upwards traffic *the despatches being to very many stations* the work is heavier and is distributed between several changing stations and junctions, especially as the facilities in the assembling yards in the coal district are not adequate for this purpose. At Moghalserai, for instance, *wagons for the same destination* may have to be picked up from various coal trains from (1) several centres in the Jherria Field (E. I. Ry.) from (2) the Jherria Field, B. N. Ry. (received *viâ* Gomoh) and from (3) the Raniganj Coal Fields. (1) and (2) are received by the E. I. Ry. Grand Chord Line trains and (3) by the E. I. Ry. Main Line or Chord Line trains at Moghalserai, where trains are formed again.

INDIAN RAILWAY TRANSPORT SERIES

No. 9

INTERCHANGE AND POOLING OF WAGONS

Each railway has its rolling stock, and under rules framed for interchange of traffic the railway, on which the traffic originates, was required to supply wagons for such traffic. And the railways which received traffic in wagons of other lines paid a certain sum fixed, on the capacity of wagons, for their use, until the wagons got back to the line they belonged to, and such payment was called "hire" and it comes to about Rs. 2-8-0 per wagon per day, in the case of an ordinary four-wheeled wagon now-a-days.

As the traffic developed and the distances, for which traffic moved, increased it took longer for wagons to return to the owning line for loading again.

Therefore, a rule was made years ago that in order to prevent a railway from getting denuded of its rolling stock for immediate use, when a certain amount of its wagons were away on another line it could call upon that line to return a certain percentage of the wagons before the time they were due back in the ordinary course.

The arrangement of returning wagons was for years confined to the return of the particular wagons of the railway to which they belonged and *vid* the junction by which they were received.

But as the traffic advanced and distances increased it was found not very economical to confine the return of wagons to the railways to their wagons only, and now it is accepted that so long as the carrying capacity in tonnage is returned, it matters not which railway's wagons they are.

In the olden days, the East Indian Railway got more wagons of other railways with traffic in them, than it sent out wagons to them. This was due to Calcutta being in those

days an important outlet for grains and seeds from Behar, the United Provinces and part of the Punjab to Europe. Gradually the order of things changed. Now the E. I. Railway sends out a large number of its wagons to Bombay and Karachi with grain, seed and cotton traffic from its stations in U. P. although Calcutta yet receives a large number of wagons loaded with grain and seeds from the Oudh and Rohilkhand Railway but not so large as it used to receive at one time.

The greatest change came with the development of traffic in coal from the Jheria and the Ranigunge coal-fields and with the reduction in coal rates that came about in November, 1906.

Now coal from these fields go to all parts of India—to the extreme north, east, south and west.

Formerly great bulk of the coal was carried to Calcutta and then shipped from there to Madras, Bombay, Karachi and other Indian ports and railed from there to stations on the Madras, Bombay, and the North-Western lines respectively; but now-a-days, particularly since the war, most of this traffic for the entire distance has to be hauled by rail, thus keeping the wagons locked up for the carriage of one consignment much longer than before. As larger number of vessels become available the old order of things, *viz.*, of traffic going *vid* Calcutta and the sea may come back.

Naturally, therefore, the demand on the East Indian and Bengal Nagpur Railways, where the collieries are situated, for wagons became very large and it became necessary for the railways to devise some means of getting more wagons for coal.

In some other parts of the world there are arrangements under which wagons of several railways are treated as of one railway, *i.e.*, they may be loaded by any railway to any railway, so long as the sending railway gets back the same capacity in wagons as it sends out, although such wagons may not all be belonging to its line. In India, owing to Government ownership of most lines, the arrangement is rendered more easy in some respects; but difficult in other ways owing to various types of wagons and long distances, with special wagons, for heavy

traffic it means light loads on railways with less or light load traffic. And the net result may not be always advantageous.

In connection with the pooling of wagons, I wrote as follows in 1918.

Pooling of Wagons.

"Arrangements for the utilisation of goods rolling stock to best advantage taking the railways of same gauge together, regardless of ownership of wagons, in order that as wagons are available goods may be loaded in them, *so long as the railways receiving wagons from foreign lines in doing so do not so use the stock as to cause shortage on particular railway or railways, which are loading traffic largely at the time,* is considered necessary during times like this. 'Pooling of wagons' of railways of same gauge in Northern and Western India to attain this end has been arranged, and this has facilitated the loading of coal because otherwise the sorting and picking out of wagons of individual railways for loading of coal to those railways involved large amount of sorting and shunting work on coal districts of Bengal and Behar. There may be same drawbacks in 'general pooling of wagons,' *e.g.*, one railway, with heavy outward traffic for long distances on foreign lines, may find itself short of stock owing to foreign railways detaining its wagons for their traffic, and the inward traffic to such line and the return of empty wagons being slow the wagons thus received may be insufficient for daily loading and, moreover, heavy capacity wagons of say the B. N. Railway may be utilised on railways having light load traffic. This will certainly mean wastage of capacity and inconvenience to the railway owning the stock of high capacity. The following extract from Droege's book on 'Freight Terminals and Trains' bears on the subject of pooling.

"When the general pooling of cars regardless of ownership is arranged, loading methods will be simplified, the cost of switching, *i.e.*, constant sorting of wagons thus involving extra shunting and turning of points and levers, reduced and many other economies introduced. The committee of the American

Railway Association on car efficiency 'is endeavouring to bring about this result and it will doubtless' succeed. During car shortage period cars are pooled not theoretically but actually. Cars are pooled in Germany where the agreement for the co-operation of State Railways of the different States went into effect on April 1, 1909, and each State contributed certain agreed proportion of cars for joint use. The spectacle of American railroads rushing a class of freight cars off their lines and loading other similar cars in the same direction, thereby hauling more cars than are necessary to move freight and 'crosshauling' empty cars, that is empties in both directions at the same time, is a striking contrast to logical and businesslike methods."

Pooling of wagons, it is held, helps the distribution, loading and despatch of coal wagons.

In dealing with the question of pooling of wagons, one cannot in India separate it from wagons required for coal traffic, because it is the coal traffic which is the largest in India and a large proportion of wagons is utilised for this traffic. Therefore in this connection we have to deal with the two together.

I quote the following from a note that I issued in this connection in 1921 (July) which was sent to the Government at the time.

"The foremost point of importance is the basis of wagon supply in the coal districts. First of all it is essential to find out very accurate information as to the raisings and stocks of collieries. Now after this information has been obtained and compiled, it should be published and sold at a nominal price so that every colliery can purchase it. The object of this publicity is first to check this information and any colliery can contradict this information if it be incorrect. Secondly, on this information will be formulated the basis of supply as far as possible, subject of course to the capacity of each colliery to receive and clear wagons. First of all wagons are supplied to each area coming within the jurisdiction of what are known as depôt or central stations (*e.,g.*, Kusunda, Bhaga, Pathardihi, Katrasgarh, etc.). Each depôt station has got a yard where wagons are received,

distributed to collieries, and again received back loaded, sorted and despatched, to the assembling yards at say at Dhanbaid, Adra, etc., etc., and the area under the jurisdiction of each depôt yard (*i.e.*, all the collieries served by this yard by means of pilots) cannot get more wagons than each such yard can cope with.

Out of the total number of wagons which each depôt station gets, each colliery receives its proportion, and that proportion is based on the raisings of the stocks, but this should be subject also to the limitations of its clearing capacity, and where the facilities in the way of sidings and loops are not sufficient, a note should be kept of what the adequate facilities should be and details given to railways so that they can take action in time. The original basis of a colliery may, in some cases, be greater than what wagons it could get, because the capacity of the depôt station yard limits the number of wagons for all its collieries and the number of wagons available is divided or distributed in ratio of the original basis.

If railways requiring coal for their own use send empty wagons of their own and label such wagons direct to the collieries and these wagons are run as one intact train, they would go straight from the point of despatch to the collieries without break and that would tremendously save work not only in the yards of the coal depôt stations (such as Pathardihi, Katrasgarh, etc.) but in other marshalling yards ahead and such rakes of empties should be loaded and returned labelled to the railway concerned (*viz.*, to such destination stations as Jhansi, Bombay, Lucknow, Lahore, Kurachee, etc.) intact, whereby the following advantages would be gained :—

(*a*) Depôt stations being thus relieved, to a certain extent (if not to a great extent) would be able to receive and deal with more wagons for coal other than loco coal (*i.e.*, public coal).

(*b*) The railway contracts for loco coal would be better dealt with in this manner. Collieries which do not get loco coal contracts would be able to get wagons for public and other coal more easily than now.

When a certain coal depôt is or depôts are fully or nearly fully engaged in receiving and distributing empties for loco and marine coal and in clearing them, when received loaded from the siding and collieries, other coal has hardly any chance.

If the system of booking empty rakes and sending them back in full train loads is found to give satisfaction and to facilitate working, there is no reason why this system should not be extended to industrial coal, *e.g.*, for mills at Ahmedabad, Bombay, Carnatic, etc.

There is another point in regard to economic use of rolling stock. When the coal rates were revised in November 1906, I was asked to put up a note on the whole question to form the basis of an agreement between the coal-carrying railways, particularly in regard to the areas to be divided between the E. I. R. and the B. N. R. and my note did form the basis of this agreement. It was suggested by me to fix, if possible, the limit beyond which the longer routes should cease to equalise with rates obtainable by the shortest route. I have given extracts from this note on pages 161 and 162 of my Monograph on Indian Railway Rates. It will be observed therefrom that in those cases of traffic for which say the B. N. Railway quoted equal rates with those of the shortest route *vid* E. I. Railway the distance say in the case of Agra, exceeded by the B. N. Railway longer route by 54% and in the case of Delhi and *vid* (for the Punjab coal) by 46%. Even a claim was made (as will be seen from the first para. on page 162 of the same book) to equalise for Cawnpore by 106% longer route. One of the strongest points, other than that of the unremunerative rates, made in that note of mine was that a very large number of wagons would be required if such circuitous routing was adopted. However, this point did not carry much weight at the time, although the Cawnpore traffic was abandoned by the B. N. Railway.

But at the present moment, reconsideration of this point might be desirable with a view to determine whether it will not

be advantageous to confine coal requirements of the Northern and North Western India, for which the E. I. Railway route will be the shortest, to collieries on the E. I. Railway, and for the South and Western India to collieries on the B. N. Railway. On page 160 of my Monograph on Indian railway rates will be found a table showing which places in India are shorter from the Bengal fields by the E. I. Railway route and also which places are shorter by the B. N. railway, whereby wagons would be occupied in transit for a shorter period as compared with the time occupied on the longer routes. Of course, when the shorter routes are congested, longer routes have to be used, the same as was done during the war. It is obvious that the employment of circuitous routes must be one of the reasons for delays to wagons and a detriment to the quick turning round of wagons.

While admitting that the pooling of wagons is useful in some ways, the sending down of rakes and of booking the rakes should be more useful ; and if an extra charge is made to industries for whom such rakes are booked, they might be willing to pay something in addition to railway freight in order to get supply of wagons in view of the loss they suffer at present.

The conference rules require that the railway on which the traffic originates should as far as possible supply the wagons, and in cases of large number of wagons being absent on a foreign railway a call is to be made by despatching railway. This rule need not be disregarded and rakes may be counted in the total interchange tonnage.

The adjustment of tonnage and the calls under Conference Rules will prevent any railway getting denuded of its rolling stock by sending such rakes.

Further, in pooling of wagons there is difficulty in the matter of spare parts of wagons which are not always available on foreign railways, and with the present pooling of all railway wagons for coal traffic this may be somewhat difficult. But under the rake system and *with wagons back to the parent line oftener and quicker, repairs will be facilitated in the*

home line shops and also covenient depots for spares could be arranged.

Under the present system South Indian railway wagons may come to the E. I. Railway and be allowed to run between E. I. Railway and the N. W. Railway without seeing the face of the South Indian Railway for months together and the same thing may happen with say B. N. Railway wagons, which may go to the Madras Railway and remain there for months and be used for light load traffic, whereas the B. N. Railway manganese and iron ore traffic may suffer on account of absence of such wagons of high capacity on the Madras Railway.

In connection with the booking of rakes of empty wagons to the coal districts it is to be borne in mind that in great majority of cases empty wagons have to be hauled for long distances to the coal districts. It is only in isolated cases such as that of O. and R. Railway wagons bringing in grains and seeds, etc., to Howrah or Khidderpore Docks that they are (or can be) diverted to the coal district for the lading of coal for up-country (or say to be back loaded to the O. and R. Railway)."

The above remarks were written in 1921, and circumstances have altered since. As might have been seen in public prints, the system of supplying wagons to colliery sidings in rakes of empty trains has been arranged. But as such rakes can only be supplied to those collieries which have sidings long enough for rakes, this may tell hard on small collieries and small takers who might get their chance for loading perhaps once or twice a week or so. But when the greater interests of a country are at stake, such sacrifices seem unavoidable. But with improve ments in facilities, better and more yards and more wagons, these difficulties will disappear.

Pooling of wagons in a comparatively smaller area may be suitable, but with heavy long distance traffic this may not be very suitable in a vast country like India.

This matter will be further discussed in the last chapter.

INDIAN RAILWAY TRANSPORT SERIES

No. 10

TRAFFIC AND TRAIN CONTROL

With improvement in the matter of general control of wagons, over Indian railways, it is essential that the internal machinery on each railway in the matter of movement of rolling stock and trains should also be improved.

In my Monograph on Indian Railway Rates (*vide* appendix IV, pages 525 to 531) great stress was laid on the necessity for increase in the number of average miles run per wagon per day. It was for these reasons that in Chapter VIII, and in the appendix above referred to, figures were demonstrated to show that in the past, on some railways, an increase in the number of wagons did not have the desired effect. It was shown that in the case of some railways, such as on the North-Western and on the B. B. and C. I. Railway with a large increase in the wagon capacity and in number of wagons, there was a heavy decrease in the number of miles run per wagon per day, so that a very large percentage of the wagon capacity and number of wagons added was not made use of. This was obviously due to the facilities for moving the wagons not being improved simultaneously with the increase in the number of wagons. Factors that may operate against quick movements of wagons and trains were summed up as follows on pages 282 to 283 of the Monograph. The delays and wastage may be due—

(I) either to the increase in the number of wagons having taken place without attempts being made first to get more work out of wagons by spending money in improvement of facilities in the way of more passing sidings, and reduced block sections, by adding to the number of passing and crossing stations, better facilities in yards at terminals, changing and junction stations.

Of course it will be said that all this means money. This is true, but experience shows in some cases part of the money spent on wagons might have been better spent on more facilities, *vide* Appendix IV of the Monograph.

(II) or to defects in the system of marshalling or grouping wagons on trains. It is generally believed by the staff at a marshalling station (*i.e.*, at a terminal or a changing station, wherefrom goods trains are made up and started) that so long as wagons on the train are marshalled for the section (for goods trains are mostly sectional trains) over which the train is run it is sufficient, thus meaning that at the end of each section marshalling has to be done again. This must cause delays in yards. It is believed that the "rate of movement of wagons depends upon various causes, the principal being the length of time a wagon is standing at stations or in sidings as compared with the time occupied in actual transit."

(III) or to defective or inadequate marshalling yards involving too many back shunts which prevent wagons always moving in the yard in the direction of the destination station; or to shunting being interfered with in the marshalling lines owing to stoppage of shunting temporarily during process of reception or despatch of trains.

(IV) or to want of through time tables for most goods trains in preference to sectional time tables.

Sectional or work trains are said to be more useful in being utilised as feeders to through trains and it is remarked by some that if railways run pick-up trains every morning from each end of a section and pick up loads and deliver empties and *vice versâ* and bring wagons to the nearest changing stations to be attached to through trains (even if this means taking wagons for a few miles in the opposite direction, to which it is intended to go) it would save delay to wagons and trains. Through trains are most useful in clearing long distance traffic and some say even loads can be sacrificed to a certain extent if fast through trains can be arranged. The late Mr. T. Robertson, C.V.O., the first Special Railway Commissioner for India

made a strong point of this, but it is doubtful whether it is best to sacrifice loads. This point will be touched again later on.

(V) or due to cross return of empties.

(VI) or to want of utility of wagons for return loads by diversion from the original route on the return direction (even to foreign lines) or being detained for loads.

In these days of heavy shortage in the capacity of railways to move traffic the maximum utility of engine or locomotive power between two points and quick movement of wagons and trains are most important factors, and an improvement of even one or two miles per day in the movement of each wagon would mean considerable gain to the railways, the country, its trade, commerce and industries.

Of course, the greater improvements in the facilities in the way of more railways, additional routes, more crossing and signalling stations, better yards, more sidings, double lines and loops will come in time as money becomes available, but in the meanwhile best has to be done by railways with whatever facilities they have.

On railways in England, there has been developed a system of " traffic control " under which certain groups of stations or certain lengths of a line are placed under the control of a " Central Control Office " which is connected by telephone with all the stations of its section or sections and also by telegraph. These stations or these sections that are connected direct with the Control office with telephone communication (in addition to the telegraph connection with the Control office) are known as Control sections and those which are connected by telegraph only are known as supervised sections.

The Control office is generally situated at the headquarters of a district, or at a central place and the Control office is well posted in all details regarding facilities at each station on its section and the capacity to receive, hold and despatch traffic and wagons at each station.

In England, this traffic control embraces the functions of formation of trains, the ordering of trains and engines, the

regulation of train movements, the control and movement of rolling stock, the restrictions and diversions of traffic, but it is to be remembered that English railways deal with concentrated traffic comprised within small areas, and therefore such areas can be easily controlled from a central control office. In India, the density of traffic varies over different lengths, and on most railways the bulk of traffic is for long distances, and on some railways the traffic is neither concentrated nor heavy at most stations. The traffic may be distributed over a number of stations. Therefore in India, traffic control may be most useful on some sections while expensive on others. Moreover, if the Traffic transportation and the Locomotive running departments are combined, the control system can be more effective.

The Controller in charge of a Control office, receives at a certain hour of the day, generally in the evening when days work is finished, the following particulars from all stations on its section.

(*i*) of empty wagons on hand.
(*ii*) of wagons waiting to be unloaded.
(*iii*) of goods waiting to be booked.
(*iv*) of goods waiting to be loaded.
(*v*) of wagons required.
(*vi*) of wagons loaded and empty, waiting to be moved by trains for 24 hours or so.

In addition, the changing stations or the terminals (where engines are changed and fresh trains are formed) send the following particulars to the Control office.

Total loaded wagons for the Up direction
„ empty „ „ „ „
„ loaded „ „ the Down direction
„ empty „ „ „
„ loaded wagons in the Up direction during the previous 24 hours.
Total loaded wagons sent in the Down direction, during the previous 24 hours.

Total empty wagons sent in the Up direction, during the previous 24 hours.

Total empty wagons sent in the Down direction during the previous 24 hours.

Total engines available.

„ „ incapaciated.

„ brake vans received during the previous 24 hours.

„ „ despatched during the previous 24 hours.

„ „ on hand.

And with the introduction of a Control office, the responsibility of the station master at changing stations in the matter of ordering of goods trains on a control section is taken over by the Controller, who with all the particulars he gets direct by telephone and telegrams is better able to know the latest requirements of each station.

The Loco Foreman at changing station also intimates to the Control office the number of engines available to be run and also what running staff he has, and particulars of engines that are disabled, of those that are delayed on the line and are overdue, and explanations for delays.

All these informations are recorded by the Control office and may also be sent to the District officer and to the Chief Transportation officer together with notes and explanations.

And the following further particulars are recorded in addition.

Trains and light engines and brakes run.

Time engine left running shed for each train.

Time of departure of train.

Time of arrival of train.

Time engine returned to shed.

Total time engine with traffic, *i.e.*, from time engine left shed to time engine returned to shed.

Total time engine in shed and round turn of each engine.

Authorised load of the train according to type of engine or engines used.

Highest load of the train on any part of its journey over the section.

Short load, if any.

In regard to movement of trains all station masters, working on a section, under the control system, observe all the ordinary procedure, rules and regulations, but in addition, they intimate every movement, *i.e.*, arrival and departure of all trains to the Control office immediately so that the Control office knows what trains are moving on the various sections under its control. As the trains move on and intimations are received, the particulars are put on to the graphic chart at once, so that, the Control office can see at a glance from the chart, the positions of the trains ahead and behind each station on the length of his section, and if necessary, the Controller can step in and issue orders that would facilitate the movements of trains. A slow goods train may be proceeding along and it may come to a point where it may delay the movement of trains behind. And a station master at a station, with facilities to arrange crossings of trains, may not use his discretion and send this slow train ahead and the train may come to a point, where it may proceed on for some stations more because of want of accommodation. In such a case, the Controller can stop a train at a convenient point in time. If a train is running say with light load and there are some wagons that can be picked up at stations by this train the Controller, who is well acquainted with all the particulars at stations ahead, can order such a train to pick up the wagons. Similarly, if goods are waiting at other stations and empty wagons are going up that way, the Controller can order some of the empties to be cut off for the traffic waiting. Suppose, an accident or breakdown has occurred which is going to delay and restrict movement of traffic, the Controller will know this at once, and he will order the stoppage of some trains at intermediate stations behind and cancel others, that may be starting in the ordinary course of events from a changing station within a short time, or in other words, he can at once prevent delays, congestions and facilitate movements. Generally speaking, the Controller is a guide to the station masters and is a pivot around which

everything moves. A station master generally sees what is the position at his station and the position at one or two stations ahead of his station or at one or two behind. An engine-changing station master knows generally what is the position in his yard and the District Traffic Superintendent knows all about his district but he is not in constant touch with the movement of every train as it is moving to and from each station. He knows the next day where the delays occurred. The engine-changing station master used to order the goods trains (through goods trains are shown on time tables but all of them may not run every day and may run as ordered) in days previous to train control, and in some cases the District officer, according to requirements, but he was not posted so well and so fresh in details as the Controller is now-a-days with the facilities of telephone and graphic chart records every moment. Each station master, each engine-changing station master and the District Traffic Superintendent have other work besides looking to movements of trains, wagonss etc., but the Traffic Controller specialises in his business and is therefore always up to date, almost to the minute, and therefore he is in a better position to act and does act at once on his own section and gives immediate orders, and thus prevents delays and facilitates movements, and as more trains and wagons are moved on a section within a given time, and quicker, it means saving all round. This Control System is gradually developing in India into an important organization and the G. I. P. Ry. is the first railway that has introduced Control System extensively, but it is to be remembered that the G. I. P. Railway is the only railway in India where the Locomotive running and the Traffic transportation departments have been combined.

The organization of railways in the various branches will be dealt with in Part III.

INDIAN RAILWAY TRANSPORT SERIES

No. 11

AIMS AND OBJECTS OF TRAIN AND TRAFFIC CONTROL AND OF POOLING OF WAGONS AND RESULTS IN MOVEMENTS OF WAGONS AND TRAFFIC

After having explained Wagon pooling and train and traffic control it may be interesting now to examine the whole thing more minutely from the point of view of results.

To effect an improvement in the work done per wagon per day is one of the main objects of the train and traffic control. At first sight, it may appear that an increase in the speed of goods trains is an important factor in the amount of miles run per wagon per day, but this is only so to a small extent and in some cases. The detentions in changing station yards counterbalance any improvements made in the running of trains, and, again, the speed and movements of goods trains between two changing stations or on sections ahead, to no small extent, depend on the capacity of the changing station yards to receive, stable, sort, marshall, and despatch wagons and trains adequately and quickly.

First as to speed:—In dealing with the speed of goods trains I wrote as follows in 1918 in my "Monograph on Indian Railway Rates":—

"A statement is appended below showing the average speed of goods trains during last four official years :—

	Miles per hour.							
	1913-14.		1914-15.		1915-16.		1916-17.	
	1st half.	2nd half.	1st half.	2nd half.	1st half.	2nd half.	1st half.	2nd half.
B. N. Railway ...	10·00	10·00	10·00	10·00	10 00	10·00	10·00	10·00
B. B. & C. I. Railway	8·53	7·90	7·95	7·94	7·95	7 95	8·04	8·06
G. I. P. Railway ...	10·70	10·34	12·45	10·08	10·34	10·18	10 24	10·12
E. I. Railway ...	15 20	15·10	15·00	16·30	16·20	16·38	16 30	16·30
N. W. Railway ...	10·28	10·36	10 44	10·29	10·37	10·13	9 22	9·85

"The Bengal Nagpur Railways shows an average speed of 10 miles per hour. It has remained stationary at this figure. The booked speed of goods trains on the Bengal Nagpur Railway vary from 12 to 18 miles per hour, except that on some sections in one direction the speed is 14 to 20 miles per hour. Out of 1,896 miles of its broad gauge mileage, 625 miles are on a grade of 1 in 101 to 1 in 200, 151 miles in grades of 1 in 201 to 1 in 300, and 119 miles on the grades of 1 in 181 to 1 in 100."

"The Great Indian Peninsula Railway average goods train speed is recorded at 10·24 miles per hour. During the last four years, the highest figure attained by this Railway was 12·45 miles per hour during the first-half of 1914-15. The Great Indian Peninsula loads per train are limited. The average train-load of freight trains is about 29 loaded vehicles against 39 to 41 of the East Indian Railway and 34 to 36 of the Bengal Nagpur, Bombay Baroda and Central India, and North-Western Railways. The Great Indian Peninsula goods trains on its Jubbulpur branch, Nagpur branch and between Bina and Delhi,

including branches on this length, have a booked speed of 18 to 19 miles per hour, except on certain lengths where it goes down to 12 to 13. It has to carry a limited load owing to steep gradients, and the bulk of this Railway's traffic has to ascend and descend the western Ghats, both from the north-east and south-east to Bombay. Out of a total mileage of 3,173 miles, more than one-fourth is on a grade of 1 in 101 to 1 in 200 and 279 miles on grades of 1 in 201 and 1 in 300."

"The North-Western Railway has gone down in its average speed to 9·92 miles from 10·37 miles per hour. Its booked speed of goods trains is 15 miles per hour except on the Ghats.

"The Bombay, Baroda and Central India Railway goods trains have the slowest speed not exceeding an average of 8 miles an hour."

"The East Indian Railway, of course, shows the best results. Its average is more than 50 per cent. greater than that of the other lines and the booked speed is about 20 miles an hour."

The foregoing observations were made in 1918.

The results in 1920-21 were very much the same as say in 1916-17, except on the E. I. Railway where there was a reduction.

Average Speed of Goods Trains (Miles per Hour).

	1920-21.	1916-17.
B. N. Railway ...	10·00	10·00
B. B. & C. I. Railway	8·77	8·06
G. I. P. Railway	10·35	10·12
E. I. Railway ...	13·50	16·30
N. W. Railway ...	9·44	9·32

It will be noticed that in the case of the East Indian Railway there was a decrease in the speed from 16⅓ miles per hour in 1916-17 to 13½ miles per hour in 1920-21 or else the figures of other railways were more or less stationary.

Next to come to the figures of average number of miles run per wagon per day on the following lines (broad gauge) in

Northern India—the results in 1916-17 and in 1920-21 were as under :—

Number of Mile rnn pev Wagon per Day.

	1919-17.	1920-21.
B. N. Railway ...	... 40 ...	... 34
B. B. & C. I. Railway ...	... 39 ...	... 40
E. I. Railway ...	... 59 ...	... 46
G. I. P. Railway ...	... 47 ...	... 34
N. W. Railway ...	... 34 ...	... 30

There was a decrease in the run per wagon per day almost everywhere; one of the reasons for this result was the bad condition in which most wagons were in 1920-21 and are even to-day. Wagons becoming unfit to run after a few miles of loaded running were, and may be yet, no unfrequent occurrences, but nevertheless it will be interesting to note that the B. B. & C. I. Railway with an average speed of 8¾ miles per hour recorded an average work of 40 miles per day per wagon, against 34 miles per wagon per day, with 10 and 10⅓ miles per hour speed, on the B. N. Railway and on the G. I. P. Railway. Therefore, it cannot be said, at least in these cases, that the speed of goods trains was the most important factor in the number of miles done per wagon per day. It is, however, true that on the East Indian Railway with a decrease of 3 miles per hour (*viz.* from 16½ miles per hour in 1916-17 to 13½ miles per hour 1920-21) in the speed of goods trains there was also a decrease in the run per wagon per day by 13 miles (*viz.*, from 59 to 46 miles). This may be due to detentions in yards, to the reduction in the number of miles run per goods train per hour and to the number of wagons found unfit to run for want of repairs; their constant detaching or repairing *en route* mean delays, and some say goods trains also lost time due to bad coal. On the B. N. Railway, although the average speed of goods trains was the same in 1916-17 as in 1920-21 (*viz.*, 10 miles per hour) the work done per wagon per day was 40 miles in 1916-17 against 34 miles in 1920-21. The

causes may have been the same as on the E. I. Railway. It may also be noted that during 1920-21 the E. I. R. and the B. N. R. carried a much heavier traffic than in 1916-17.

In handling wagons, it is essential that as much care should be paid to the quick movement of loaded wagons as of empty vehicles. As the empty vehicles come back to the loading points quicker, the work of loading and despatching traffic is also quickened. In some places, more attention is said to be paid to quick movements of loaded vehicles than of empty vehicles.

I have always held, and said in my previous pamphlets and publications, that in the matter of coal traffic trains, the rake system of running of both loaded and empty wagons intact from such collieries as have sidnigs for a rake to one destination and back should be encouraged, and trains should be made up for as long distances as possible. I have also said in the past that proper and adequate coal marshalling yards to attain these ends should be made in the coal districts or as near to them as possible, which yards should do the marshalling and grouping of wagons on trains not only for the home lines but for foreign lines. These remarks were repeated by me in one of the pamphlets that I gave to the Railway Committee. I also said that in order to attain these ends if accommodation was provided in the coal district yards to hold back wagons even for two or three days to form solid trains for one destination it would be money well spent. Such detentions at the start and the system of such trains would help to turn round wagons quickly, (say wagons for Lucknow, Delhi, Amballa, Ghaziabad, Lahore, Ludhiana, Kurachee, Bombay, Bhusaval, Jhansi, Nagpur, Ahmedabad, Waltair, Madras, etc.). On the Union Pacific Railway of America "the coal is moved from the assembling points in the vicinity of the coal mines in solid train loads and empties are returned in the same manner," and this is said to be the cause of good results on that railway in the matter of work done per wagon per day.

The long leads of goods traffic are said to help the formation of trains for long distances. The average lead of goods

traffic on the following railways was as follows during 1920-21 :—

	I Total tons carried.	II Total freigh tton miles.	III Average miles per ton.
B. N. Ry. ...	8,906,000	2,068,155,000	... 232
B. B. & C. I. Ry ...	4,371000	1,044,870,000	... 239
E. I. Ry. ...	18,998,000	5,639,812,000	... 296
G. I. P. Ry. ...	10,192,000	2,975,335,000	... 291
N. W. Ry. ...	11,776,000	3,188,052,000	... 270

The average number of miles per ton or the average lead of traffic per ton has been arrived at by dividing the total freight ton miles by the total number of tons carried. It will be observed that the average lead of goods traffic on the East Indian Railway was 296 miles (the highest figure) and the average number of miles run per wagon per day was also the highest on the E. I. Ry., *viz.*, 46 miles. This result, again, might have been, to a small extent, helped by the comparatively high average speed of goods trains on the E. I. Railway (*viz.*, 13½ miles per hour). But it is also to be noted that on the G. I. P. Railway although the average lead of traffic was 291 miles (very much near to that of the E. I. Railway) and the speed of goods trains was 10 miles per hour the work done per wagon per day was 34 miles, against that of 40 miles on the B. B. & C. I. Railway, on which line the average lead of goods traffic was but 239 miles and the average speed of goods trains was also the slowest, *viz.*, 8·77 miles per hour. Obviously, therefore, there were more delays in station yards or at terminals on the G. I. P. Railway than on the B. B. & C. I. Railway.

The results either in the speed of goods trains or in the work done per wagon per day do not show improvements, but there were deterring circumstances such as those mentioned above.

In train and traffic control (*i*) the movement of both loaded and empty wagons quickly in and out of loading and unloading lines ; (*ii*) avoidance of delays in changing station and terminal

yards ; (*iii*) the increased speed of goods trains; (*iv*) formation of goods trains with wagons for as long distances as possible and (*v*) proper grouping and marshalling of wagons on trains should be aimed at, in trying to increase the number of miles run per wagon per day. The only factor which the Control Department cannot control is the lead of the goods carried and the quick removal of traffic from terminal goods sheds by the merchants after the goods have been received there, which it is the business of the Commercial Department to look into. For improvement in this matter high demurrage or penalty charge is and should be made if removals do not keep pace with the arrivals.

Further, one of the debatable points in goods train working is whether it is more economical to run more freight traffic in large train loads at a relatively low speed or in limited loads at a higher speed. This point has been recently brought up in England but it is not a new one. The late Mr. (afterwards Sir) Thomas Robertson, the first Special Railway Commissioner for India, made a special point of this in his report on administration and working of Indian Railways, twenty years ago, but it was pointed out at the time that it was not the speed of goods trains so much as the terminal facilities for receiving and despatching traffic, the facilities at stations in dealing with trains, and the capacity of the changing station yards in dealing with wagons and trains and the number of line clear and crossing stations that operated against or in favour of quick movement of goods traffic. This being the position, it was held at the time that the running of more trains with light loads would mean more locomotive and running expenses generally, and also reduced loads per-wagon (if wagons were despatched quickly with light loads without waiting for full wagon loads) without any appreciable difference in the capacity of the Railway to handle more traffic. These arguments hold good even to-day against reduction of loads to increase speed. But at the same time, it cannot be overlooked that for the carriage of "smalls," *i.e.*, odd packages, it is essential that the service should

be quickened. In America, it was held, a few years ago, that within a distance of 300 miles small packages, which were carried at higher rates than wagon load traffic, should not take more than 24 hours to get to destination. In India too "smalls" generally pay a higher rate of freight than wagon load traffic. Running of van goods trains every day and use of through road vans (*i.e.*, wagons with loads of say 3 to 4 tons between two central stations, say Howrah to Allahabad or Lucknow or Lahore or from Bombay to Delhi, Jubbulpur, or from Kurachee to Agra, Lahore, Multan) should be encouraged. In England also, owing to competition by motor transport, small weight traffic by goods trains receives quick transit, but in India this kind of traffic suffers the most detentions.

The system of running through wagons from certain stations or certain groups of stations to certain places on nominated days in a week and the holding back of loads or packages for or asking merchants to book packages on nominated days for specific places may help matters.

In connection with the continuance of pooling of wagons my ideas are that pooling arrangement should have a further and a fair trial and more closely watched, but there are certain important factors in this connection that might be brought out. Some of them are as follows :—

(1) Special wagons designed for particular traffic such as iron ore, manganese ore, rails or high-sided wagons for heavy loading of coal should be used, as far as possible, for such traffic only. The main point in this connection is that when such wagons are sent to foreign lines they should be sent back to the owning lines instead of being retained by the receiving lines and used there for light load traffic and a corresponding capacity in total tonnage in other types of wagons replacing them. Heavy capacity wagons will be wasteful on lines where they cannot be fully utilised and their absence from railways where they can be fully and profitably utilised is certainly a loss to the Government and to the country, which must be avoided. Such wagons ought to be marked "non-poolable" wagons.

(2) In regard to the repairs it is most essential that wagons should be put into proper order as soon as practicable. And for this purpose, particularly to ensure safety of train running and to avoid risks of accidents, return of wagons to parent lines workshops for repairs, even in small batches, may be useful, if such repairs cannot be executed at once in the shops of railways using such wagons temporarily. Delays in repairing such wagons and using them inspite of their condition may mean temporary carriage of more traffic but this must involve more depreciation and eventually a far greater time lost before getting the wagons healthier again. In respect of repairs in the foreign railway shops there is the difficulty in the matter of spare parts, and if say a Madras or a South Indian wagon, after having come to the Bengal local lines, finds its way to the N. W. Ry., and then gets damaged there or has to be repaired there and spare parts are not available it means a serious delay. Therefore, if " within the Pool " an arrangement is made that S. I. Ry., and Madras wagons would be confined as far as possible to traffic between the coal fields and those railways it would be solving the problem of quick repairs to them. It is with this object in view that I had suggested that if the traffic in coal (say Loco coal, which can be controlled) to the Southern India is confined to the B. N. Railway and to collieries on that line a great deal of saving in wagon capacity could be secured and, at the same time, there would be no increase in shunting. Similarly in respect of traffic to Western and Northern India if these are confined to the shorter routes (for instance Bombay and Ahmedabad traffic to the collieries on the B. N. R. and to the B. N. R. route mostly; I. M. R. traffic for Central India to the B. N. Ry. Katni Route; Delhi, Agra, Punjab and U. P. traffic to the collieries on the E. I. Ry. and to the E. I. Ry. route), then, in addition to increasing wagon capacity, by reducing the time occupied by wagons on circuitous routes, convenient depôts for repairs, with spare parts of foreign railway wagons, could be established at places say like Ghaziabad, Delhi, Umballa, Nagpur, Jubbalpur, Katni, Amalner, Ujjain, Waltair, etc., etc., and this procedure

will not increase shunting on the Coal Districts. This suggestion would to a certain extent mean grouping of railways for purposes of pooling, and this to my mind would be more effective in attaining better results.

(3) In order to avoid any one railway profiting unfairly under the Pooling arrangement, by using wagons of other lines, action on the part of the Government is necessary. The Government, as the owner of all the railways, should see that each railway provides rolling stock required for its traffic, *i.e.*, to say one railway should not be encouraged to use for instance for its local traffic wagons of foreign lines in excess of the number of wagons, which such railway has sent to foreign lines or in other words one railway should not be allowed to curtail investment in rolling stock required for the loading of traffic originating on its line and to use foreign railway wagons for such loading. If it is found that one railway has excess rolling stock, for instance the Oudh and Rohilkhand Railway or the E. B. Railway, and another railway has shortage of rolling stock for traffic originating on its line say the G. I. P. Railway and, that a large number of say O. and R. Railway or E. B. Railway wagons are being employed on the G. I. P. Railway or the B. B. and C. I. Railway and such wagons help these railways to carry increased traffic locally (*e.g.*, from Ahmedabad or Sabarmati to Bombay over the B. B. and C. I. Railway or from the Cotton districts in Berar and Khandesh on the G. I. P. Railway to Bombay) in that case the G. I. P. or the B. B. and C. I. Railway should be asked to arrange with the Government to take over such wagons with the capital expenditure transferred also to such lines or hire should be paid at a higher rate and wagons sent to the owning lines when required there. The names of these railways are used in the way of illustration, pure and simple, and not as specific cases.

(4) Another object of pooling arrangement is to reduce empty wagons mileage and it should, therefore, be seen particularly that this is being attained. During a period of

temporary lull there may be the tendency to return wagons to the owning lines to save hire and then to call for the wagons again the moment the lull is over. This should be avoided. When the owning railway does not need the wagons back, *i.e.*, slackness exists both on the owning and the using lines, then the wagons should be stabled and kept on the lines where they are but a very nominal rate of hire only should be paid on them during such periods, because even if the wagons had come back to the owning lines they would have been standing idle there too.

It is said that it is too early to judge the results of pooling wagons in India. With one ownership, *viz.*, that of the Government, and with the absence of private wagons on Indian Railways, pooling of wagons might be advantageous in India if the whole thing is planned and worked properly. With the tremendous amount of shunting, that is required in the coal fields in picking out wagons in the depôts, sub-depôts, and at the colliery sidings and in the assembling, sorting and marshalling yards, delays would be serious and the capacity reduced if there was no pooling of wagons. Therefore pooling of wagons should be given a very fair trial and results watched. The chief object of the pooling, speaking very broadly, is to see that a larger amount of traffic is moved by the use of the same number of wagons. Therefore, it is most essential to watch and see whether this great object is being gained before the pooling is made permanent or is abolished, and to illustrate what is meant by these remarks I would invite particular attention to the following paragraphs.

The point is what have been the effects of pooling of wagons in the matter of clearing traffic and fair treatment all over India. Let us take the broad gauge railways of Northern India, such as the B. N., B. B. and C. I., E. I., G. I. P., O. and R., and N. W. Railways. If we compare the results of 1916-17 with those of 1920-21 we might come to understand the position. The following table shows the figures of 1920-21 and

1916-17 side by side. There was no general pooling in 1916-17 but there was in 1920-21 :—

	Total goods traffic in tons.		
	1920-21.	1916-17.	
B. N. R. ...	8,906,000	8,156,000	
B. B. & C. I. R.	4,371,000	4,661,000	
E. I. R. ...	18,998,000	182,48,000	
G. I. P. R. ...	10,192,000	11,140,000	
O. & R. R. ...	3,454,000	3,463,000	
N. W. R. ...	11.776,000	10,945,000	but in 1913-14 the N. W. R. carried 12,288,000 tons.

From the foregoing figures it will be seen that, excepting in the case of the E. I. R. and the B. N. Railway, more traffic was cleared by other railways before general pooling.

Comparing the results of 1920-21 with those of 19 6-17 the E. I. R. and the B. N. R. between them carried an excess traffic of 15 lacs of tons, and it is remarkable that each railway accounted for an equal quantity to make up 15 lacs, *viz.*, 7½ lacs of tons each. At first sight, one would be inclined to think that this increase was mostly accounted for by coal traffic, but this does not appear to be so. Whereas the total excess traffic of the E. I. R. in 1920-21 (compared with 1916-17) was 7½ lacs of tons, coal only accounted for an increase of 1,73,000 tons (less than 2 lakhs) and, in the case of B. N. Railway out of 7½ lacs of tons the increase in coal was but 96,000 tons (or less than one lakh). In Railway Board's Administration Report for 1920-21 we find the following observations.

"During the period from April to December, 1920, the East Indian Railway was an average nett debtor railway to the extent of approximately 3,203 wagons and the B. N. Railway to the extent of 1,534 wagons, while during the first 3 months of 1921 the E. I. Railway was an average nett debtor railway

to the extent of approximately 4,514 wagons and the B. N. Railway to the extent of 2,845 wagons."

The Railway Board, in their report, emphasised the point that relief was afforded to the coal despatching lines by other lines by restricting traffic. The Railway Board's remarks in continuation of those quoted above were as follows :—

"The nett debits represent the assistance given to the two coal-despatching lines by their connected railways and in order to give this assistance these railways had to restrict their own traffic. Similarly in order to maintain the supply of wagons in the coal fields both the E. I. Railway and the B. N. R., especially the former, had also to restrict their general merchandise traffic."

The figures show that while the railways like the G. I. P., B. B. and C. I., O. and R. or the N. W. Railway carried lesser traffic the E. I. R. and the B. N. Railway carried much more general merchandise traffic, or in other words restricted general merchandise traffic was carried on railways other than the E. I. R. and the B. N. Railway, with a view to give assistance to the two latter railways in the matter of general merchandise traffic by such other railways sending their wagons to the E. I. Railway and the B. N. Railway. Thus it would appear that such wagons were not used for the purpose intended, *i.e.*, they were mostly used by the two latter lines much more for general merchandise traffic than for coal traffic. This being the position a very important question arises here. In the first place, it is to be asked whether all the railways have realised the position. Then the next issue is whether it is right that the traders and industries on other railways than the E. I. R. and the B. N. R., trading and interested in commodities other than coal, should be compelled to restrict their business largely in order that the similar traders and industries on the E. I. R. and the B. N. Railway should benefit by the two latter railways having freer supply of wagons at the expense of traffic and business on other railways, which have to spare their wagons for the E. I. R. and the B. N. Railway. If such wagons were used

solely and mainly for coal traffic, as it was intended to be, there would be some grounds for giving preference to the E. I. R. and to the B. N. Railway for purposes of carriage of coal for railways, Indian marine, Indian industries; but it appears that whereas the object aimed at in getting other railways to stint their own general merchandise was to enable coal-despatching railways to place more wagons for coal traffic, the latter railways in practice used such wagons more largely for general merchandise than for coal.

Even if we compare figures of 1918-19 with those of the year 1920-21 we also come to somewhat similar results.

	Total goods traffic in tons.	
	1918-1919.	1920-1921.
B. N. R. ...	8,146,000	8,906,000
E. I. R. ...	18,974,000	18,998,000

The increased total goods traffic of all descriptions on the B. N. Railway was 760,000 tons and on the E. I. Railway 24,000 tons in 1920-21, compared with 1918-19, but the increase in coal traffic, taking the same periods, on the B. N. Railway was 236,000 tons, and on the E. I. Railway the coal traffic in 1920-21 was actually less than in 1918-19 by 51,000 tons.

Therefore, it is difficult to realise that the B. N. Railway in the nett did not gain by the pooling of wagons. Less wagons used for coal than intended and more wagons for other traffic on E. I. R. and B. N. Railway might be due to the coal districts not being able to take the wagons, that came from foreign lines and, therefore, they were used for other traffic instead of being returned unused and empty. Thus, before sending wagons from foreign lines, the Wagon-Director should satisfy himself that they can be received and utilised by the coal districts.

As already stated, it is claimed that with pooling of wagons the shunting of wagons should be less, and this was in fact one of the main objects of the pooling.

Separate figures of shunting mileage of engines as distinct from train mileage figures are not available for 1916-17 or for previous years so that any proper comparison cannot be made between the periods when there was no pooling of wagons and periods when pooling of wagons came into operation. We, have however, separate figures available for 1919-20 and 1920-21. Taking these two years we find that there was more shunting in 1920-21 on the coal-despatching lines than in 1919-20. It is true the total traffic was bigger during 1920-21 but even the comparison of percentage of shunting mileage to train mileage in 1920-21 with similar percentage in 1919-20 shews the following results in respect of the coal-despatching lines :—

	Percentage of shunting mileage to total train mileage.	
	1919-20.	1920-21.
B. N. R.	28·88	31·61
E. I. R.	25·45	26·05

It will thus be seen that there were increases in the percentage of shunting mileage on the coal-despatching lines. The only conclusion that can be drawn is that had it not been for pooling the results would perhaps have been worse still if we have to accept the statement of the E. I. Ry. that pooling reduces shunting generally. But the B. N. Ry. does not fully admit this. The increase may also be due to a larger number of sick wagons having to be detached more often.

The total shunting mileage and its percentage to total train mileage during 1920-21 on the various broad gauge lines of India were as follows :—

	Total shunting mileage.	Percentage of shunting mileage to total train mileage.
B. N. Ry.	3,301,539	31·61
B. B. & C. I. Ry. ...	1,799,155	20·00
E. B. Ry.	2,116,583	46·88
E. I. Ry.	7,015,334	26·05

	Total shunting mileage.	Percentage of shunting mileage to total train mileage.
G. I. P. Ry.	4,192,570	18·31
M. S. M. Ry. ...	971,594	17·73
N. W. Ry.	6,445,380	34·24
O. & R. Ry.	936,867	17·92
S. I. Ry.	320,735	13·83

The figures of shunting mileage were the highest on the E. I. Ry., but this was due to its very heavy traffic; the noticeable feature is that while the percentage of shunting mileage to total train mileage was higher on the B. N. Ry. (*viz.*, 31·61 per cent.) it was lower (*viz.*, 26·05 per cent.) on the E. I. Ry. This may be mainly accounted for by the fact that on the E. I. Ry. there is, in addition to coal, a big merchandise traffic which on the E. I. Ry. does not require so much shunting as its coal traffic does whereas on the B. N. Ry. the biggest traffic is coal and, there is not as much other traffic on the B. N. Ry. as there is on the E. I. Ry., in ratio of its coal traffic. And as the latter traffic in the colliery districts involves heavy shunting the B. N. Ry. shews a greater percentage of shunting mileage.

The N. W. Ry. traffic is mostly its own, and the wagons used for that traffic are also mostly its own. So that pooling of wagons cannot very much affect this line. The large shunting mileage on N. W. R. was probably due to—

(1) Its traffic having to be picked up from a very large number of stations, which again means delivering empty wagons at such stations for purposes of loading.

(2) Its very numerous junctions, branches, parallel lines, loops, etc., involving heavy shunting operations because a number of trains have to be broken and formed again at the junctions. When however, trains are not broken and formed again a large amount of attaching and detaching of wagons have got to be done at the numerous junctions in any case.

(3) To the feature that its train loads differ on various sections of its line meaning reductions in or additions of wagons from and to trains, which also means more shunting.

On the E. B. Ry. the percentage of shunting mileage to train mileage was the highest. This was mainly due to the train mileage itself not being so heavy, as is evident from the fact that the work done per engine per day was much less on E. B. Ry. than say on the E. I. Ry. The reason for this is not very far to seek. The E. B. Ry. total broad gauge mileage is less than 650, and that too is in various directions (*i.e.*, not made up of one long run). The runs are say from Calcutta to Goalando and *vice-versâ*, between Calcutta and Naihati, between Lalgola and Naihati or Lalgola and Calcutta or between Calcutta and Santahar. When I say Calcutta I also mean the jute mills and jute baling presses in the suburbs of Calcutta. Besides these facts the shunting on E. B. Railway must be very heavy owing to the existence of a very large number of jute mills between say Calcutta and Kanchrapara. Whereas in Bombay the cotton mills are not largely served by railway sidings or by sidings of long lengths the jute mills of Bengal have got a large number of long railway sidings to serve them.

In the case of the G. I. P. or the B. B. and C. I. Railway, the shunting mileage was less as the railways get concentrated traffic. The G. I. P. Ry. gets almost full train loads of coal and grain from the B. N. Ry. and the E. I. Ry. and grain traffic from the O. and R. Ry. The B. B. and C. I. Ry. too has the same advantage for its broad gauge section, which gets concentrated traffic from the metre gauge at Ahmedabad and also from other railways, and in coal.

It will thus be seen that excepting in the case of coal-carrying lines the reasons for higher or lower shunting mileage is not so much the pooling of wagons as particular traffic and working conditions.